MYCOLOGIA

OFFICIAL ORGAN OF THE MYCOLOGICAL SOCIETY OF AMERICA

VOL. XXXIII SEPTEMBER–OCTOBER, 1941 NO. 5

MYCOLOGISTS IN RELATION TO OTHERS[1]

DAVID H. LINDER

As you are well aware, we are living in a very uncertain period, one in which many peoples have lost not only their political, but also their scientific freedom, while others have had their privileges curtailed or postponed. It is for us, who still have freedom of action, a solemn duty not only to consider what we are able to do to maintain our liberty as mycologists, but also what we can do to serve our country by helping in building or in aiding our defenses and still continue to add to the knowledge of our subject that has been built up through the efforts of past generations.

For the good of our souls, we might as well admit that taxonomic mycology started out in much the same spirit as the boy stamp collector, but the growth of knowledge of the fungi and the resulting broadened view has led to the recognition of the value of the subject for scientific study and contacts have been made with many fields, among which are cytology, genetics, medicine, chemistry, and agriculture. In view of these broad contacts of mycology with other branches of scientific endeavor, the Mycological Society with the diverse interests represented in its membership, should be in a position to aid in national defense and welfare. Today, therefore, it seems desirable to point out a few ways in which we can assist the national cause, and at the same time to suggest to the Society that its members be formulating additional ideas as to how we may be of greater service.

[1] Address of the retiring president, presented before the Mycological Society of America at Philadelphia.

[MYCOLOGIA for July–August (**33**: 341–451) was issued August 1, 1941]

In spite of crop restriction and our present so-called surplus of certain farm products, I have a feeling that we are going to be happy over the fact that we have them, if not for our own country, at least for peoples of other countries who have had the misfortune to have been prevented from sowing crops. Just as we may be glad to have a reserve of farm crops, I feel equally sure that we shall also have need of all possible reserve knowledge of plant diseases and the fungi that cause them, in order to meet unexpected conditions that may develop as the seasons vary from year to year. For that reason, nothing should be done that will hinder the increasing of our knowledge of plant and forest pathology. While this is a pat on the back for phytopathologists, it should be added that it is not for the "spray gun artists" as the late Dr. Thaxter so aptly described some members of the profession, but for those individuals who have a sound training in taxonomic mycology—the people who know how to classify the organisms with which they are working, who know the morphology and life-histories and who can, as a result, work out effective and efficient control measures. While a well trained mycologist can do fully as well as a phytopathologist, coöperation between the two groups is the end to be desired. There is absolutely no need for either set of disciples to feel that one has the corner on knowledge to the exclusion of the other.

Medicine is another field in which the mycologists may be of great service. They can assist in building up a reserve of technical ability in time of war. The culture methods of the mycologists are not so unlike those of the bacteriologists that we who are older or physically decrepit cannot at least train young men and women in the techniques of isolation, culturing, and staining of bacteria. People so trained under the mycologists, but with the helpful suggestions of the doctors, would in certain ways have an advantage over those trained only in bacteriological methods for they would be meeting the problem with an entirely new point of view and at the same time would be interested in the possible presence of fungi in infections. In a national emergency, then, there is no reason why, by adjusting our courses to suit the needs, we cannot help train laboratory technicians who can be of great assistance to the more highly trained products of the medical schools and thus free

more doctors for the care of the sick and wounded among the fighting forces or the civilian population.

Whether in war or in peace, medical mycology has a very definite place in the scheme of things, a fact that I believe is more definitely recognized today than in past years. Those of us who have been interested in medical mycology have seen that under the wings of the doctors, the study of fungi that cause diseases has become more and more confusing. This, in part, has been the result of insufficient knowledge of the fungi themselves, and in part because of placing too great emphasis on giving high sounding names to different symptoms that may be produced by a single fungus, or else a result of relying too greatly on gross morphological characters of the fungi as they appear on one or two culture media. Let us admit that in spite of the faults of the past procedures, they at least have furnished us with a starting point and a target at which to shoot. That the shooting has been pretty good has already been demonstrated by the fact that it has been proven that a single species of fungus may produce many of the different symptoms that have gone under sonorous, and to the layman, bewildering medical names. Also, it has been brought to light that a single species may break up into many races, so many that even the mycologists are bewildered although they now begin to show signs of recovery and are beginning to bring some order out of the chaos. Even with the fungi that cause skin blemishes and which have been studied more than any other forms, there still remains much to be done that is strictly within the realm of mycology. The first point that needs attention is the straightening out of the taxonomy of the species concerned. In view of the long list of species that have been described, and also of the lengthy synonymy of a few of the species that have been studied in recent years, it is evident that there remains much to be done and that there is room for more investigators. These investigators should have taxonomic training and should have some knowledge of the nutritional requirements of the fungi. It is my firm conviction that the almost universal use of Sabouraud's agar has done more to confuse taxonomy than any single factor. Peptone or peptone and sugar in agar, as used in the past, are not only unbalanced and do not furnish all the elements necessary for normal growth of the

fungi, but when these substances are supplied, they are in too great concentration. Test-tubes do not furnish a normal habitat, but when to this is added unfavorable nutritional factors, there is little wonder that the organisms go wild and produce all sorts of mutations. However, taxonomic training and cultural technique are not all that are necessary. A good general mycological background, including morphology and cytology, obtained from the study of a wide range of fungus groups as they appear in nature and not in books, is necessary in order to avoid the mistake of placing a single species in two or three orders, in more families, and in ten or more genera. Indeed, with our present knowledge of these forms, the hasty creation of new families and orders is to be condemned since, as has already happened, related species become so far separated by premature and improper arrangement that bringing them together may be a matter of chance. However, an attempt should always be made to determine generic affinities and to point them out so that eventually the fungi may be arranged according to a natural rather than to an admittedly temporary and artificial system of classification. In spite of the mistakes of the past, medical mycology has a very bright future, a future that will be all the brighter when there is close coöperation between the mycologists and the doctors. At present there is nothing to stand in the way of full coöperation except the M.D.'s prejudice against the Ph.D. and perhaps their feeling of omniscience. What is needed is a partnership between the two in which each will perform his special duties while working for the common cause of increased knowledge and the betterment of human welfare.

There are other fields to which mycologists may contribute their bit, but only a few points need be suggested where coöperation may be of assistance, although undoubtedly each member may have many other ideas. In the textile industry we can help, not only by assisting in improving methods of protecting cloth from the various fungi that cause mildew, but also in devising methods of retting fibers that may make available neglected plants which could furnish substitutes for products that may be cut off by embargoes in a foreign country. In the field of chemistry there is much to be learned about the possibilities of producing organic compounds

or about species that are capable of producing higher yields of a specified enzyme. Finally, in agriculture, with the coöperation of the chemists, it may be possible to find methods for the further utilization of the by-products of the farms. The new Federal Regional Laboratories have made a start in this direction but there is no reason under the sun why an individual who is qualified should sit back and wait for the government to do all the work. After all, the greatness and the high standards of living in this country have not resulted from people sitting back and waiting for the government to tell them what to do. They have gone ahead and done the work on their own initiative.

So far only the relations of mycology to other fields of endeavor have been briefly discussed. It now seems fitting that we should look at ourselves somewhat critically in an endeavor to see if we cannot profit by some of our mistakes and improve our opportunities. This portion of the paper is directed chiefly to taxonomists for it seems that if they are to furnish the names of the tools with which others work, they must strive for stability in nomenclature and must be able to make known the results of their efforts. The first plea to be made is that our members be more conscientious about conforming to the International Rules of Botanical Nomenclature. American taxonomists have at last been able to convince most of the world but the die-hards, that the type concept is an invaluable aid in securing stability in nomenclature and naturally we are enthusiastic about its universal application. If we want that concept to hold, we must be willing to be equally conscientious about applying the regulations that we like less well. While infractions of three or four rules may be cited, I refer specifically to the matter of Latin diagnoses. This requirement has been cussed and discussed in several of our meetings and in spite of the cogent reasons given for the maintenance of that rule, descriptions of new species still appear either without or with only sufficient Latin diagnosis to cover the minimum requirements that will enable the author's name to be perpetuated. Either treatment indicates an insular point of view on the author's part—certainly not the broader outlook that represents the ideals that we should have for scientific work. The danger of continuing to violate the code that is meant to serve not only Americans, but also Chinese,

Russian, and French as well, can well be illustrated by the conditions in Europe and Asia today. A parallel situation existed. Two or three leaders of cliques not liking the rules and regulations that governed international standards and relations, took matters into their own hands and broke one by one the rules to which the civilized world subscribed. Today the result is chaos and wanton waste of effort that promises to lead nowhere. If we American taxonomists don't want to live up to the rules to which we have subscribed, we are going to find that others will be equally loath to live up to those that they don't like, and the results botanically will be the same as the results politically. It is therefore up to each of us to live up to the rules made by the majority, but there is absolutely no reason why the minority should not endeavor to convince members of the International Congress that their procedures are greatly superior to the old, and endeavor to substitute a more workable and acceptable regulation or set of regulations. Clarification and simplification of the rules are needed, but until the desired changes are brought about in accordance with established methods, taxonomists are urged to live up to the present rules and not to take matters into their own hands.

We cannot complain about the International Rules if we do not do our part. One of the places where we have in the past fallen down on the job is in regard to the selection of generic names for conservation. The English in spite of the worries that they have undergone, have submitted a creditable list and in doing so they have given us a definite challenge to carry on their work. Not only is it a challenge, but it is also an opportunity for American mycologists to carry on the work and apply the type concept as it is accepted by the International Code. The task should be undertaken with a scientific point of view and with the paramount idea of obtaining stability in nomenclature. The application of the principle of usage should be kept to a minimum since a name that appears to be acceptable in the United States may neither be correct, nor acceptable in other countries.

There is also room for continued and even increased monographic studies since it is only by the comparison of a large amount of material of one genus or several related genera, by the thorough inspection of the literature, and through the experience thus re-

ceived, that truly fundamental taxonomic work in the field of taxonomic mycology may result, and the many tangles and uncertainties clarified. Furthermore, such monographic studies should not be confined to one region or one country since many species are widespread and the possibility exists that an organism that appears new to science because it has not previously been found on this continent may nevertheless have been found and described under one or two or even more names elsewhere. Unfortunately, the monographic studies while of immense value, nevertheless are a distinct handicap to the author since the matter of publication of longer papers is one that poses a problem that seems almost insuperable. The regular botanical journals are crowded, even with restrictions as to the length of an article, because of the great diversity of subjects submitted. The few periodicals that are able to accept more lengthy monographic treatments are not able to care for the many papers that might be submitted. In a word, there is quite definitely room for a taxonomic journal for cryptogamic botany, as well as for phanerogamic botany, and this journal need not in any way compete with our own MYCOLOGIA that must take care of the various needs and interests of approximately three hundred and fifty members. Because of the financial status of most scientific institutions, it seems justifiable to point out just one example of how, through unified action among libraries and with the coöperation of the scientific workers, money could be saved that would more than support two or three taxonomic journals. Our libraries have recently paid $45.00 for five parts, *not five volumes,* of *Botanisches Archiv,* which contains many lengthy and heavily padded papers such as would be expected when authors are paid by the page. Theoretically, all libraries should have a complete file of as many magazines as possible, but today with bibliofilm service available, that is not necessary. Accordingly, if all libraries would boycott journals of the kind just mentioned, the prices would drop to proper levels. Meantime, through the agency of one or two conveniently located libraries that are equipped for microfilm service, articles necessary for the prosecution of research could be obtained without undue delay or hardship. The current papers are surveyed in the Department of Agriculture's *Plant Science Literature* so that it should not be impossible to know what

is going on in any special field of botany and to obtain copies of the needed papers. By utilizing the advantages thus furnished, the resultant economies would more than offset the bibliofilm service and still leave sufficient funds for the support of one or two taxonomic periodicals costing $7.00 to $10.00 a year. If cutting out the one journal alone will allow these savings, even greater economy will result when more journals of a like nature are dropped, and then American money can be turned to the support of American science. It seems that if American students, who are now forced to pay for extra pages and plates and reprints, are willing for the love of the game to write articles without any more compensation than they receive from seeing in print a piece of work that has been well done, they should deserve first consideration and support.

FARLOW HERBARIUM,
HARVARD UNIVERSITY,
CAMBRIDGE, MASS.

NEW AND UNUSUAL SPECIES OF DISCOMYCETES[1]

BESSIE B. KANOUSE

Botanical expeditions to various parts of North and Central America have provided collections of Discomycetes, some of which are of more than usual interest. Of the fungi collected, several are believed to be new species, and they are described in this paper. They belong in the following genera: *Belonopsis, Cenangium, Ciboria, Coronellaria, Dasyscyphella, Helotium, Tryblidaria* and *Unguicularia.* One variety of *Helotium* is raised to specific rank, and a new combination is made.

The collections are deposited in the Herbarium of the University of Michigan. The color names inclosed in parentheses are from R. Ridgway's Color Standards and Nomenclature.

Belonopsis montanensis sp. nov.

Apothecia superficialia, 1.5–4.5 mm. lata, primo globosa dein applanata, margine crenulato, sessilia, excipulo griseo-brunneo, hypothecio pseudoparenchymatico, hymenio aurantio; asci cylindraceo-clacati, longe pedicellati, 8 sporis, 130–155 × 9–12 μ; sporae hyalinae, aciculares, rectae vel saepe curvatae, 38–50 × 1.5–2 μ, 3 vel plus septate; paraphyses apice curvatae, tenue epithecium formantes.

In foliis emortius fagi et abietis.

Apothecia superficial, 1.5–4.5 mm. in diameter, at first globoid, the hymenium enclosed by the excipular layer, at maturity applanate to convex, the margin irregular with triangular patches of the remains of the excipular layer, broadly sessile, soft waxy, solitary, exciple pseudoparenchymatic, gray brown, hypothecium thick pseudoparenchymatic, hymenium " Mikado orange," to " deep chrome " when dry, slightly paler when moist; asci-cylindric-clavate, long-stemmed, apices accuminate, 8-spored, 130–155 × 9–12 μ J +; spores hyaline, acicular, straight or slightly curved, 38–50 × 1.5–2 μ, 4 (apparently sometimes 8 or more) celled, parallel in the upper part of the asci; paraphyses numerous,

[1] Papers from the Herbarium of the University of Michigan.

hyaline, filiform, twisted into coils or spirals at the apices, sometimes branched, colorless, forming a thin epithecium.

On fallen leaves of beech and on fir needles, Echo Lake, Flathead National Forest, Montana, July 19, 1928, G. B. Cummins.

This fungus is a typical species of *Belonopsis*. The margin is made conspicuous by the remnants of the covering layer that remain. In this feature the species resembles *Stamnaria equiseti* (Hoff.) Rehm and *Melachroia xanthomela* (Pers.) Boud. The twisted paraphyses are a second outstanding character. Although it is a small fungus it is conspicuous both in its macroscopical and microscopical characters.

Cenangium tennesseense sp. nov.

Apothecia erumpentia, sparsa vel caespitosa 2–4 in catervae, carnoso-cariacea, brevi stipitata, 2–3 mm. lata, 2–2.5 mm. alta, badia, umbrina exsiccata, hymenio nigro-brunneo, subtiliter furfuracea; asci 100–120 × 10 μ; sporae late fuscideae, hyalinae vel subhyalinae, non septatae, 11–14 × 6–8 μ; paraphyses filiformes, apice brunneae granulosae.

In ramulis emortuis.

Apothecia erumpent singly or in groups of 2–4, fleshy-leathery, short stipitate, 2–3 mm. in diameter, 2–2.5 mm. in height, "maroon" when moist, drying "bay," becoming enrolled, exciple pseudoprosenchymatic, fibrillose striate and minutely furfuraceous from the outermost layer of cells which are long, loosely interwoven, minutely rough, and light brown in color, hypothecium pseudoprosenchymatic, hyaline, hymenium becoming black-brown when dry; asci cylindric, thick-walled, 8-spored, 100–120 × 10 μ, J +; spores ovoid-fusoid, to broadly fusoid, containing one large central guttula and a small one at each end, irregularly uniseriate, hyaline to subhyaline, 1-celled, 11–14 × 6–8 μ; paraphyses filiform, narrowly clavate upwards, 3–4 μ in diameter, partially filled with brown coloring matter.

On dead twigs of deciduous wood (hazel or blue beech), Elkmont, Tennessee, June 11, 1939. L. R. Hesler *12139*. Part of type is deposited in the Univ. of Tennessee.

The delicate outermost layer of the exciple is easily rubbed off exposing a smooth red-brown layer underneath. Only with careful handling of the specimens will this character be observed.

Ciboria rufescens sp. nov.

Apothecia breviter stipitata, 2–3 mm. lata, stipibus 1–2 mm. altis, flavido-aurantiacea, sanguinea, exsiccata; asci 35–60 × 7–8 μ, 8 sporis; sporae 7–8 × 3.5 μ, nonseptatae, hyalinae, fusoideae; paraphyses filiformes.
In foliis emortuis Alni.

Apothecia short stipitate, firm-fleshy, gregarious, 2–5 mm. in diameter, 1–2 mm. in height, "apricot orange" when fresh, "dragon's blood red" when dry, exuding a red juice when crushed in water, stipe slender, smooth, concolorous with the hymenium, exciple pseudoparenchymatic, cells thick-walled, hypothecium pseudoprosenchymatic; asci clavate, 8-spored, 35–60 × 7–8 μ, ascus pore J +; spores fusoid, hyaline, 1-celled, 7–8 × 3.5 μ, biseriate in the ascus; paraphyses filiform.

On decaying leaves of *Alnus* sp. Hoh River, Oregon, June 30, 1939, A. H. Smith *14710* (type). Additional collections A. H. Smith *13579*, Spruce, Washington on leaves of *Alnus* sp.; A. H. Smith *13509* on old leaves of *Acer* sp., Lake Quinault, Washington.

This is a common species in the western woods on old leaves of deciduous trees. The rich red color of the dried plants is very characteristic and in the fresh condition the bright yellow is no less so. A bright red juice is exuded when the fungus is crushed in water.

Ciboria tropicalis sp. nov.

Apothecia superficialia, alba, pallide alutacea exsiccata, subtilites furfuracea, 2 mm. lata, .5 mm. alta, pseudoparenchymatico; asci cylindriceo-clavati, apicibus latis, (80) 90–110 × 8–11 μ; sporae leves, hyalinae vel subhyalinae, nonseptatae, subalantoideae vel subfusoideae, 11–14 × 4–5 μ; paraphyses pausae.
In foliis emortuis Cocolobae (?).

Apothecia superficial, tough-waxy, solitary, short-stipitate, applanate, 2 mm. in diameter, white when fresh, pale alutaceous when dry, externally minutely furfuraceous, stipe .5 mm. in height, .5 mm. thick, expanding into the base of the disc, concolorous with the disc below, shading into pale brown upwards, hypothecium pseudoparenchymatic; asci cylindric-clavate, broadest at the apex, (80) 90–110 × 8–11 μ, 8-spored, ascus pore J +; spores smooth, hyaline to subhyaline, 1-celled, inequilateral, irregularly subalantoid-sub fusoid, 11–14 × 4–5 μ, filled uniformly with fine granular contents, uniseriate in the ascus; paraphyses scarce, filiform.

On veins on underside of fallen leaves of *Coccoloba* sp. (?), Valentin, British Honduras, June 24, 1936, E. B. Mains, *3582*.

When stained with iodine the hypothecial tissue and the ascus pore stain a bright blue color. The disc remains flat in the dry condition.

Coronellaria Castanopsidis sp. nov.

Apothecia sessilia, gregaria, superfilialia, 250–300 μ lata, asci lata clavati 45–55 (70) $\times$ 13–15 μ, latis membranis, 8 sporis; sporae hyalinae, 14–16 $\times$ 4 μ, pseudoseptatae, multeguttulatae; paraphyses filiformes, hyalinae, ramosae, laxum epithecium formentes.

In foliis emortuis Castanopsidis.

Apothecia sessile, gregarious, superficial, 250–300 μ in diameter, plane to slightly convex, soft waxy, smooth, "russett" outside, hymenium "pale cinnamon," exciple composed of irregularly hexagonal, dark brown cells at the base, the upper portion formed of elongated, thin-walled, subhyaline hyphae-like cells extending to the margin and forming a pallisade, hypothecium pseudoprosenchymatic; asci broadly clavate, 45–55 (70) $\times$ 13–15 μ, thick-walled, 8-spored, ascus pore broad, stained bright blue with iodine; spores hyaline, fusoid, 14–16 $\times$ 4 μ, spuriously septate, containing irregularly shaped guttulae, biseriate in the asci; paraphyses hyaline, filiform, branched above, extending beyond the asci and forming a loose epithecium.

On under side of leaves of *Castanopsis chrysophylla,* Mt. Hood, Oregon, October 14, 1922, C. H. Kauffman.

Dasyscyphella palmae sp. nov.

Apothecia gregaria, alba, 1 mm. lata, pallide brunneo-hirsuta, fasciculatis; pilis; asci cylindraceo-clavati 100–120 $\times$ 8–9 μ; sporae aciculares, hyalinae vel subhyalinae, multiseptatae; paraphyses numerosae, filiformes, hyalinae.

In putrescentibus petiolis palmarum.

Apothecia gregarious, white, short stipitate, 1 mm. in diameter, 1 mm. in height, hairs on the stipe and exciple rough, pale brown at the apices, fastened together in fascicles with a dark brown incrustation which adhers to the middle portion, capped with flat, cushion-like caps; asci cylindric-clavate, 100–120 $\times$ 8–9 μ, 8-spored, ascus pore J +; spores acicular, 60–95 $\times$ 2–3.5 μ hyaline to faintly greenish, many septate, breaking easily at the septa, completely filling the asci; paraphyses numerous, hyaline, filiform, 1.5 μ in diameter at the apices.

On decaying petioles of palm leaves, Valentin, El Cayo District, British Honduras, July 2, 1936, E. B. Mains *3712*.

A characteristic feature of this species is the braided appearance of the spores within the asci.

Helotium belisense sp. nov.

Apothecia solitaria, breviter stipitata 2 mm. lata, 1 mm. alta, albida, rubro-brunnea exsiccata; asci cylindriceo-clavati, 70–80 × 7–8 μ; sporae hyalinae, nonseptatae, fusoideo-ellipsoideae, suballantoideae, 7–8 × 3.5 μ; paraphyses filiformes, simplices vel ramosae.

In foliis emortius Ilicis.

Apothecia solitary, short stipitate, 2 mm. in diameter, 1 mm. high, fleshy-waxy, whitish tinged with brown when fresh, red-brown when dry, stipe concolorous with the hymenium, hypothecium pseudoparenchymatic, asci cylindric-clavate, 8-spored, 70–80 × 7–8 μ, ascus pore J +; spores hyaline, 1-celled, irregularly fusoid-ellipsoid, slightly allantoid, 7–8 × 3–3.5 μ; paraphyses filiform, simple or sometimes forked at some distance below the middle, 1.5 μ in diameter at the apex.

On under side of decaying leaves of *Ilex* sp., El Cayo District, Valentin, British Honduras, June 25, 1936, E. B. Mains *3606*.

Helotium Piceae (Kauff.) Kanouse, comb. nov.

From a collection made in Colorado on decaying needles of *Picea Engelmanii*, Doctor C. H. Kauffman (Papers Mich. Acad. Sci. **1**: 107. 1921.) published a description of *Helotium sulphuratum* (Schm.) Phill. var. *Piceae* Kauff. His comment upon the variety was, "This probably deserves more than a varietal rank." The chief difference between the species and the variety is the difference in spore size. In *H. sulphuratum* the measurements are given as 12–17 × 3–4.5 μ, in the variety *Piceae* they measure 10–12 × 5–6 μ.

On September 6, 1934, Dr. E. B. Mains collected a discomycete on fallen needles of *Picea canadensis* at Marquette, Michigan, which agrees well with Kauffman's Colorado material. The spore size is practically the same in the two collections of fungi. The results of a study made possible by having this additional material seems to confirm Dr. Kauffman's suggestion that the variety is

worthy of species ranking. The new combination *Helotium Piceae* (Kauff.) Kanouse is made for the fungus. The type is the Colorado fungus cited by Dr. Kauffman (l.c.). This together with the Michigan collection (Mains *34–60*) is deposited in the Herbarium of the University of Michigan.

Sarcosphaera gigantea (Rehm) Kanouse, comb. nov.

In 1899 Harper collected a fungus on Mackinac Island, Michigan, which Rehm (Ann. Myc. 3: 517, 1905) described as *Pustularia gigantea*. By virtue of its apothecia which split geaster-like, it belongs to the genus *Sarcosphaera*, where Seaver (N. Am. Cup-Fungi 1928) has placed it. Seaver, however, considered it a synonym of *S. coronaria* (Jacq.) Schröt.

In July 1940 D. E. Stuntz and A. H. Smith collected specimens of a fungus from soil in Cascade Glen, Ann Arbor, Michigan, that agree closely with Rehm's account of *P. gigantea*. Like the fungi from Mackinac Island, the Ann Arbor specimens have spores that measure 10–12 × 6–7 μ whereas the spores of *S. coronaria* measure 15–18 × 8–9 μ. This difference is considered to be sufficient to establish Rehm's species. One would hesitate to place the Ann Arbor fungi in *S. coronaria*. The facts seem to justify a new combination for the small-spored fungus described by Dr. Rehm. Since it is unquestionably a valid species of *Sarcosphaera* the name *Sarcosphaera gigantea* (Rehm) Kanouse is applied to it.

Tryblidaria washingtonensis sp. nov.

Apothecia solitaria, sessilis, superficialia, .5–.75 mm. lata, subcarbonosea, nigra, applatatan exsiccati; asci cylindrici, 45–55 × 15–20 μ; sporae ellipsoideae vel subovoideae, muriformes, hyalinae vel subhyalinae, pallico brunneae, 18–20 (30) × 7–8 μ; paraphyses crassae, septatae, hyalinae, membrana brunnea summae cellae.

In decorticato ligno et Physcia (?).

Apothecia solitary, sessile, superficial, .5–.75 mm. in diameter, subcarbonaceous, black, circular, applanate on drying, edge of disc slightly elevated; asci broadly cylindric, 8-spored, 45–55 × 15–20 (30) μ, ascus pore J +; spores ellipsoid, to slightly allantoid when young, narrowly subovoid ellipsoid when mature, thick-walled, slightly constricted at the median septum, muriform, hyaline to subhyaline when young, pale brown when mature, 18–22 (30) ×

7–8 μ; paraphyses stout, septate forming 3–4 elongated bead-like cells, the apical cell capped with a thick, dark brown wall.

On decorticated wood of *Chamaecyparis nootkatensis* and upon a foliose lichen (Physcia ?) growing upon the wood, Sol Duc Park Trail, Olympic Mountains, Washington, June 26, 1939, A. H. Smith *14487* (type): additional collection A. H. Smith *14486*.

Unguicularia oregonensis sp. nov.

Apothecia superficialia, cupuliformia, sessilia vel sub stipitata, minuta, 300–380 μ lata, alba, pilosa pseudoprosenchymatica, 35–50 × 7–8 μ, 8 sporis; sporae leves, hyalinae, non septatae, ellipsoideae, 7–8 × 3–3.5 μ; paraphyses filiformes, hyalinae, apice curvatae.

In stromatibus Eutypae.

Apothecia superficial, cupulate, sessile to substipitate, soft waxy, minute, 300–380 μ in diameter, white, clothed with hyaline, smooth hairs that are distinctly recurved at their apices, hypothecium pseudo prosenchymatic, pale brown in color; asci cylindric-clavate, 35–50 × 7–8 μ 8-spored; spores smooth, hyaline, 1-celled, ellipsoid, 7–8 × 3–3.5; paraphyses filiform, curved at the apices, hyaline.

Growing on the stroma of a *Eutypa* sp., Mount Hood, Oregon, 1500 ft. elevation; October 1, 1922, L. E. Wehmeyer.

The small size of the apothecia, the recurved hairs and paraphyses are the distinguishing characters of the genus *Unguicularia*. This species is distinct from the other known species of the genus.

UNIVERSITY OF MICHIGAN,
ANN ARBOR, MICHIGAN

A NEW SPECIES OF CERATOSTOMELLA ON THE DATE PALM [1]

DONALD E. BLISS

(WITH 11 FIGURES)

Wilting and sudden death of mature date palms have been observed (1) in the Coachella Valley of California at various times during the last ten years. Among the fungi isolated from roots of affected palms is a species of *Chalaropsis* which in culture produces perithecia of the genus *Ceratostomella*. This fungus is described and identified in the present paper.

DESCRIPTION

Ceratostomella radicicola sp. nov.

Hyphae hyalinae, 3–10 μ in diam., septatae, ramosae; coloniae e griseis atrae.

Status Chalaropsis: Conidia dimorpha, endogena et exogena; endoconidiophora recta, hyalina, ampulliformia, 100–190 μ longa, 7–10 μ lata, 1–3-septata, ex apice endoconidia formantia; endoconidia continua, tenui-tunicata, hyalina, magnitudine variabilia, plerumque 8–15 $\times$ 6–10 μ, cylindrica apicibus truncatis vel rotundatis, catenulata, saepe in massas mucosas agglutinata; macroconidiophora procumbentia, hyalina, septata, sympodice ramosa; macroconidia exogena, hyalina dein olivaceo-fusco, crasse-tunicata, continua, ex ovata ovoidea basi truncata, plerumque 15–22 $\times$ 11–16 μ, singillatim in hyphis brevibus successive nata.

Status ascophorus: Perithecia lageniformia, solitaria; bulbus pallide tinctus, fere sphericus, 180–320 μ in diam., partim vel omnino immersus, mycelio laxo tectus; appendices e nullis multae, fuscae, varie ramosae, 35–90 μ longae; rostrum fuscidulum, apicem versus hyalinum et fimbriatum, attenuatum, 440–980 μ longum, 24–71 μ in diam.; asci deliquescentes, non visi; ascosporae hyalinae, ellipticae, lateribus inaequaliter convexis, continuae, 8–15 $\times$ 2.5–4 μ, tegumento mucoso vestitae, 8 vel pauciores in dispositione sectionibus aurantii simili glomeratae, extrusae et ad apicem rostri globum pellucidum formantia.

Hyphae hyaline, 3–10 μ in diameter, septate, branched; colonies gray to black.

[1] Paper no. 430, University of California Citrus Experiment Station, Riverside, California.

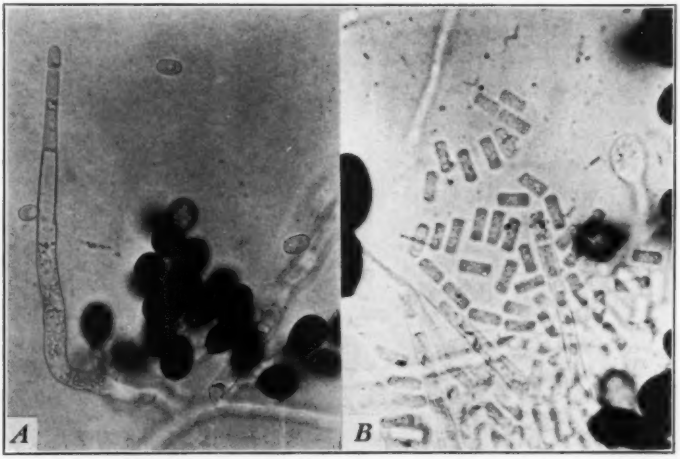

FIG. 1. *Ceratostomella radicicola*. *A*, endosporophore, with an endospore being pushed out at the tip and with a macrospore attached to the basal cell (× 395); *B*, endospores, showing cylindrical shape and general appearance when newly formed (× 867).

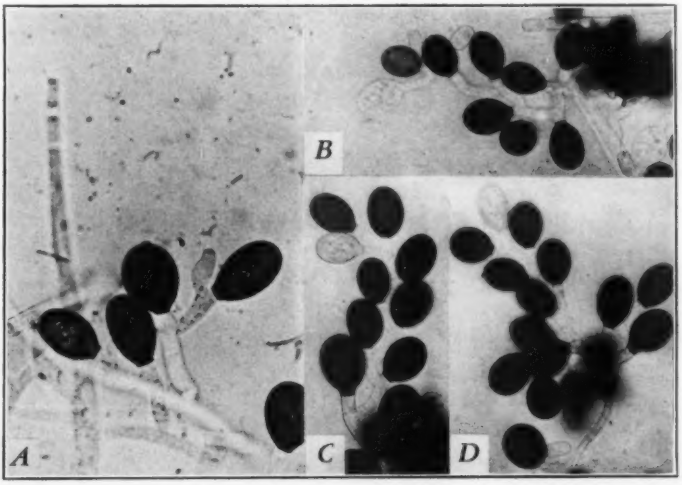

FIG. 2. *Ceratostomella radicicola*. *A*, young macrosporophore, showing the sympodial type of dichotomous branching and the acropetal succession in which the macrospores are formed (× 895); *B*, *C*, *D*, older macrosporophores (× 495).

Chalaropsis stage: Conidia of two kinds, endogenous and exogenous; endoconidiophores erect, hyaline, vase-shaped, 100–190 μ long, 7–10 μ wide, 1- to 3-septate, forming endogenous spores from tip; endoconidia continuous, thin-walled, hyaline, variable in size, mostly 8–15 $\times$ 6–10 μ, cylindrical with flattened or rounded ends, catenate, often collecting in slimy masses; macroconidiophores procumbent, hyaline, septate, with sympodial branching; macroconidia exogenous, hyaline then dark olive-brown, thick-walled, continuous, ovate to ovoid with a flattened base, mostly 15–22 $\times$ 11–16 μ, borne singly on short hyphae, maturing in acropetal succession.

Perfect stage: Perithecia flask-shaped, solitary; bulb faintly colored, nearly spherical, 180–320 μ in diameter, partially or completely submerged, covered with a loose weft of hyphae; appendages none to many, dark, variously branched, 35–90 μ long; beak dark colored, becoming hyaline and fimbriate at the apex, tapering, 440–980 μ long, 24–71 μ in diameter; asci deliquescent, not observed; ascospores hyaline, elliptical, sides unequally convex, continuous, 8–15 $\times$ 2.5–4 μ, covered with a mucous sheath, found in groups of 8 or less, standing side-by-side like the sections of an orange, extruded to form a pearly bead at the end of the beak.

Species heterothallic.

Habitat: Roots and trunk of *Phoenix dactylifera* L., Indio, California.

Types: Type specimens deposited with the Mycological Collections, Bureau of Plant Industry, Washington, D. C.; cotypes sent to the Farlow Herbarium, Harvard University, Cambridge, Massachusetts, and to the herbaria of the University of California at Berkeley, California, and at the University of California Citrus Experiment Station, Riverside, California. Mycelial culture placed at the Centraal Bureau voor Schimmelcultures, Baarn, Holland.

CULTURAL CHARACTERS

In pure culture the colonies vary from light gray to black in color, depending on their age and on the nature of the substrate.

FIG. 3. *Ceratostomella radicicola.* *A*, two mature endosporophores, showing the repeated division of the apical cell to form a chain of endospores; *B*, endospores, showing the wide variation in size and shape; *C*, mature, detached macrospores with heavy perispore wall, flattened end, and dense cytoplasm; *D*, macrosporophore with 8 spores formed in acropetal succession; *E*, young endosporophore; *F*, endosporophore with macrosporophore attached to the basal cell. (All $\times$ 923.)

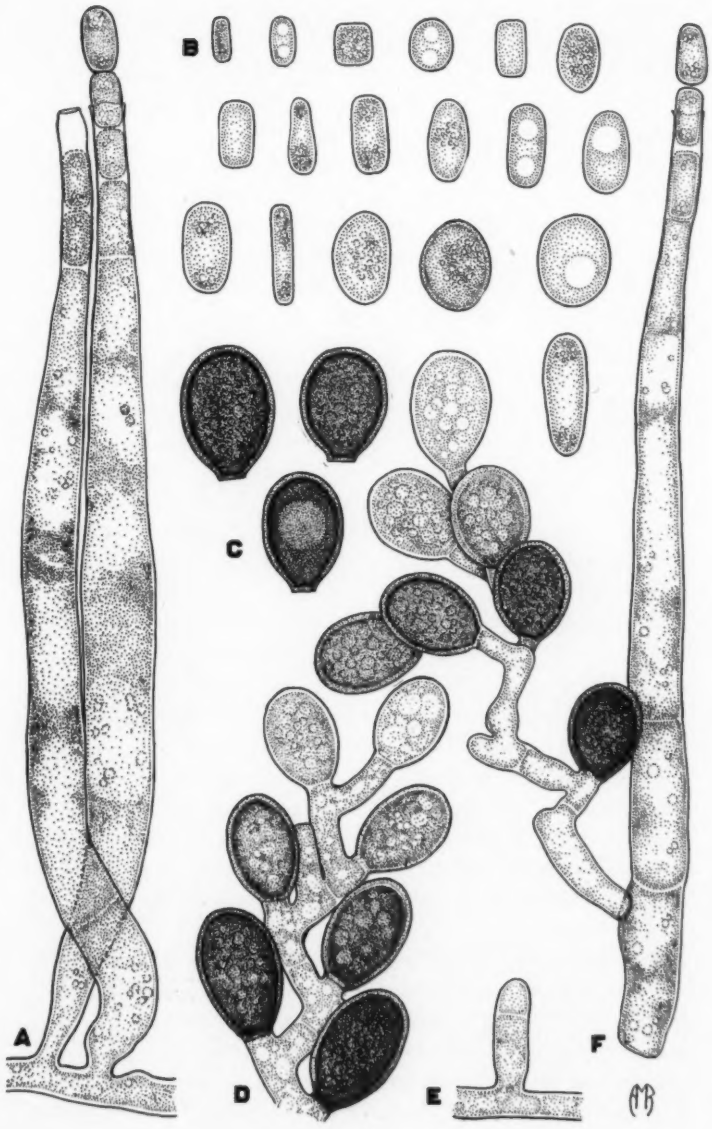

FIG. 3

Colonies with many macrospores are dark, while those in which endospores predominate or in which there is much aerial mycelium are light colored. Glucose-potato agar produces dense mycelial growth; corn-meal agar gives a comparatively sparse mat of hyphae.

The endosporophores (FIGS. 1, 3, and 4) consist of a basal cell and from one to three additional cells. The apical cell elongates greatly and produces many spores endogenously by repeated divisions of the protoplast. The tip of the sporophore is ruptured, and the endospores are pushed out in a long chain or in a droplet of slime, the procedure depending on the relative humidity of the air (FIG. 10).

Although usually hyaline, the endospores may become brownish with age. They are nearly cylindrical at first (FIG. 1, *B*), but the ends become rounded in the early stages of germination. The germ tube (FIG. 4, *I*, *J*, and *K*) may be lateral or terminal. Development of a new colony is very rapid under favorable circumstances. Young endosporophores (FIG. 4, *L*) are produced within a few hours from the time of spore germination, and macrospores appear only a little later.

The macrosporophores (FIGS. 2 and 3, *D* and *F*) exhibit the sympodial type of dichotomous branching that constitutes the principal diagnostic character of the genus *Chalaropsis*. This system of branching is indeterminate, but the total number of spores on one sporophore is usually not greater than 10. Although hyaline at first, the macrospores (FIG. 3, *C*) become darkened by the development of a dark, thick-walled perispore with a roughened surface. There is no tendency for macrospores to stick together in masses, as is the case with endospores and ascospores. At maturity the macrospore is filled with dense cytoplasm and often contains a large globule.

Germination of the macrospore results in the rupture of the perispore (FIG. 4, *A* and *B*) and the production of a germ tube. A vesicle (FIG. 4, *E* and *F*) may form if the spore does not free itself from the perispore. The thallus which develops from a macrospore cannot be distinguished from that of a germinated endospore. Endosporophores (FIG. 4, *G*) are differentiated from the germ tube almost immediately. Macrosporophores may branch from the

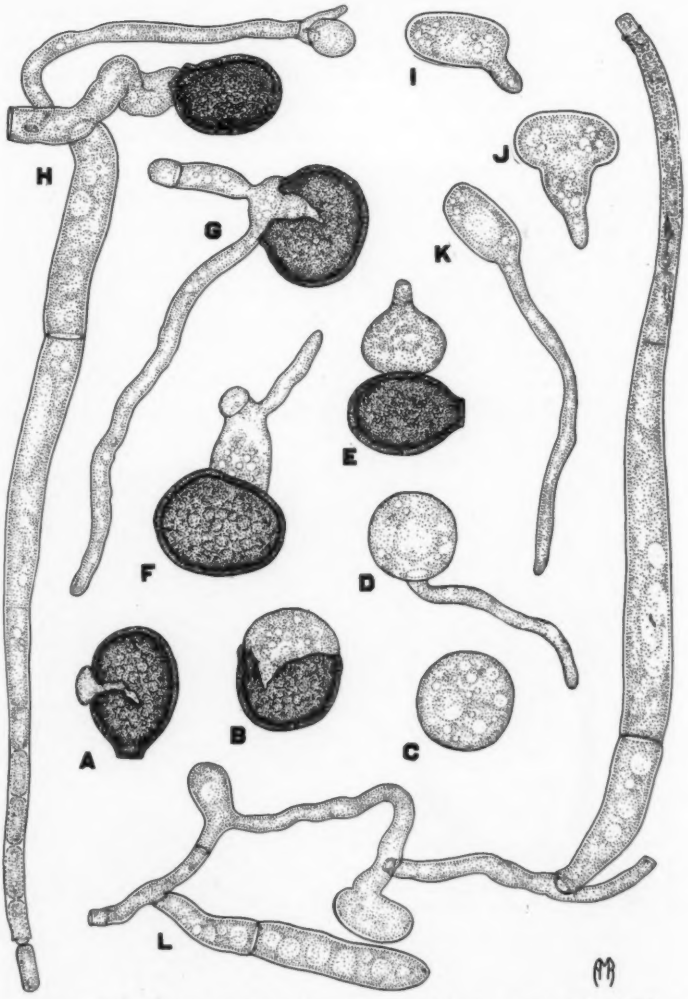

FIG. 4. Germinating asexual spores of *Ceratostomella radicicola* (× 923); *A*, *B*, macrospores with ruptured perispore; *C*, a macrospore freed from the perispore; *D*, a naked macrospore with germ tube; *E*, *F*, macrospores germinating by means of a vesicle; *G*, early stages in the development of the endosporophore; *H*, portion of a young thallus with a macrosporophore in an early stage of development; *I*, *J*, *K*, *L*, stages in the germination of endospores.

vegetative hypha (FIG. 4, *H*) or from the base of the endosporophore (FIG. 3, *F*).

The perithecia (FIGS. 5, *A*, and 7, *E*) are of typical *Sphaeronaema* form. They have been observed only on artificial media. The appendages (FIGS. 5, *B* and *C*, and 7, *B*) are located most commonly on the upper half of the bulb and sometimes form a ring about the base of the beak. They resemble the appendages of *Ceratostomella paradoxa* as described by Dade (**3**). The beak bears at the tip a fringe of hyaline hyphae (FIGS. 6, *B*, and 7, *A*) which measure 56–112 μ in length. These hyphae stand close together at first but separate to support the beadlike droplet of ascospores which are forced upward through the beak. The hyphae of the perithecium retain the ability to form endospores, although this is not commonly demonstrated.

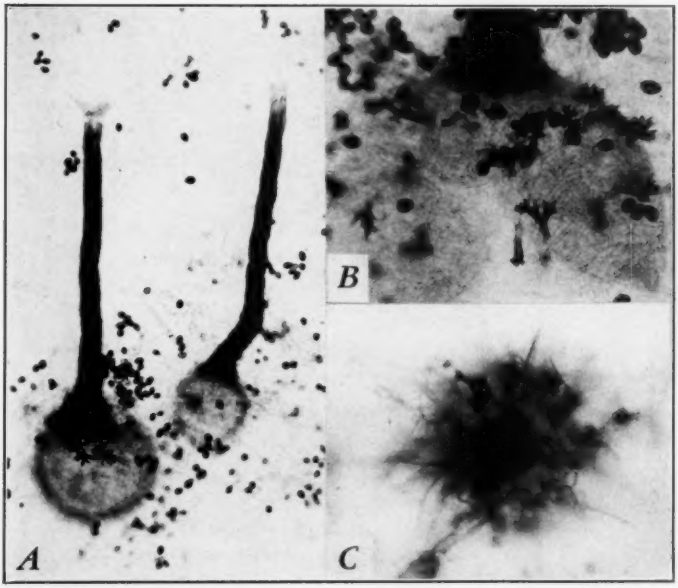

FIG. 5. *Ceratostomella radicicola*. *A*, two mature perithecia with spherical, slightly colored bulbs and long, darkened beaks (× 78); *B*, *C*, appendages on the bulb of the perithecium: *B*, side view (× 152); *C*, top view (× 115).

No walled ascus has been observed in the examination of this fungus. It is supposed that the asci deliquesce at an early stage in the development of the ascospores. When mature, these spores are extruded from the perithecial cavity to form a pearly bead at the end of the beak. The mucous sheath about each spore (FIGS.

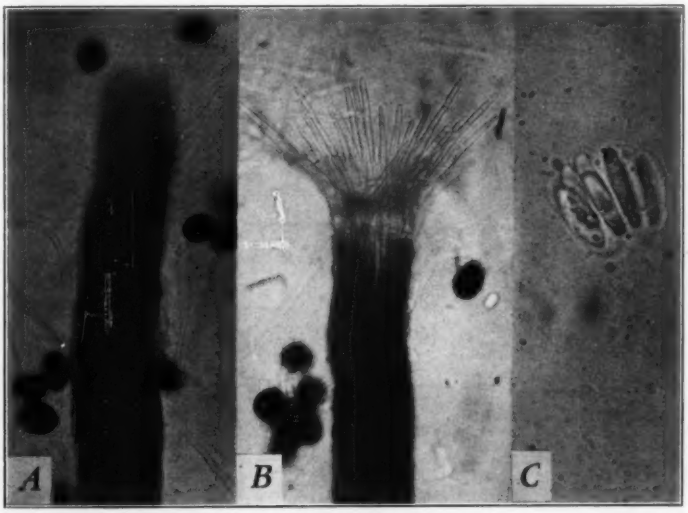

FIG. 6. *Ceratostomella radicicola*. *A*, apex of an unopened perithecial beak (× 332); *B*, apex of mature perithecial beak with fringe of hyaline, fingerlike hyphae opened by the extrusion of ascospores (× 332); *C*, group of ascospores held together by mucous (× 1050).

6, *C*, and 7, *C* and *D*) tends to hold the spores together even in the presence of water. This property makes it rather difficult to separate individual spores.

Heterothallism was demonstrated by mating certain single-spore cultures. In the first successful experiment, a culture from a single endospore was mated with a culture from a single macrospore. Perithecia formed along the line of union between the two colonies.

IDENTITY OF THE FUNGUS

The form genus *Chalaropsis* was erected in 1916 by Peyronel (**11**) on a type species called *C. thielavioides* Peyr. Similar fungi

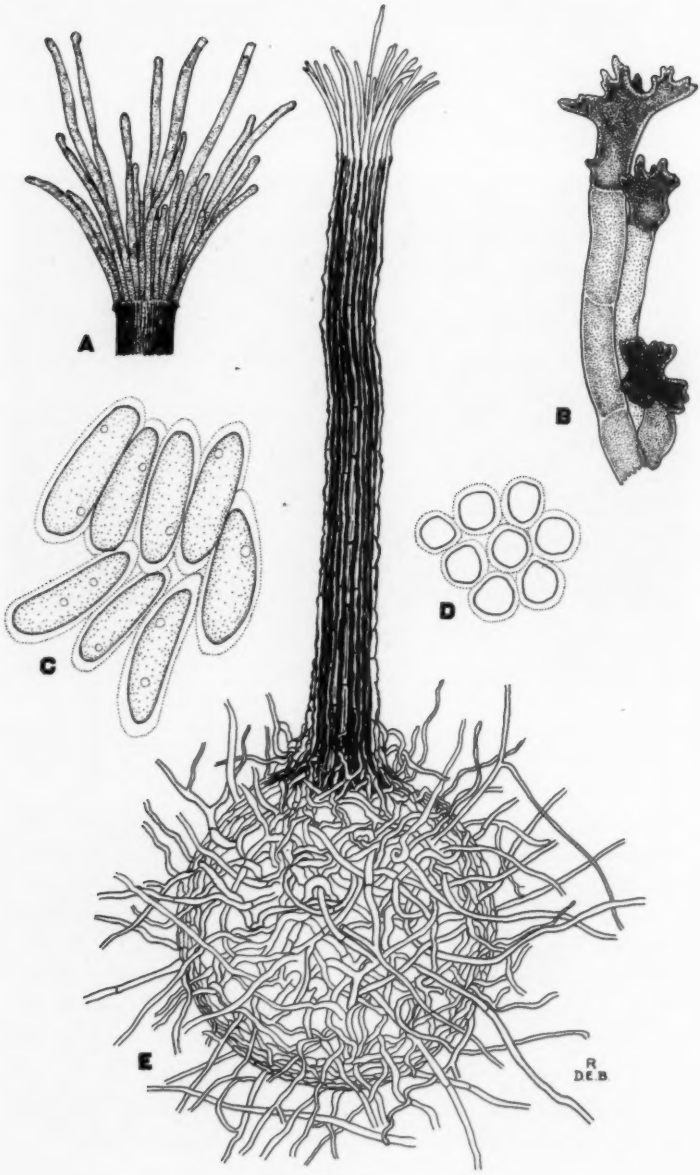

FIG. 7

have since been cultured (**4**, **5**, **7**, **8**, **10**) from various herbaceous and woody plants in Europe and the United States. All of these forms have been referred to *C. thielavioides*. Jackson and Sleeth (**6**) isolated "an endoconidiophora form of *Ceratostomella*" from *Platanus orientalis* L., which may also be related to these fungi. The *Chalaropsis* from date palms resembles the type species in

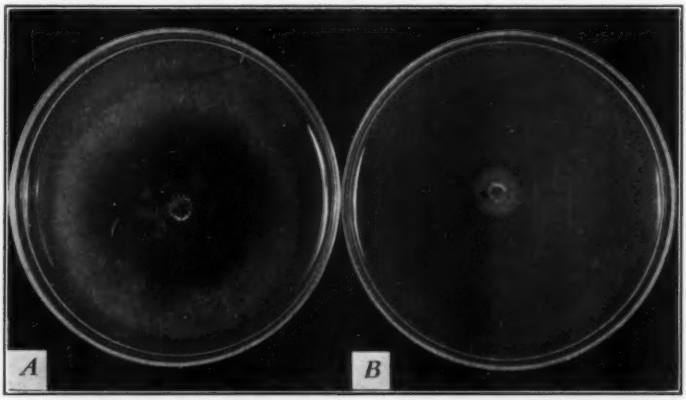

FIG. 8. Mycelial cultures on corn meal agar, incubated for 72 hours at 28° C. *A*, *Ceratostomella radicicola*; *B*, *Chalaropsis thielavioides*. (× 0.52.)

many respects, but because of the perfect stage and because of certain morphological and physiological differences, there seems to be good reason for creating a new species.

Comparisons between *Chalaropsis thielavioides* and the *Chalaropsis* from date palm were made on two mycelial cultures which had been held under identical conditions in the laboratory for a period of seven years. The culture of the type species had been isolated from *Lupinus albus* L. by Professor Peyronel in Italy; the other culture had been isolated by the writer from *Phoenix dactylifera* L. growing near Indio, California. It is thought that

FIG. 7. *Ceratostomella radicicola*. *A*, hyaline fringe at the apex of a perithecial beak, showing the formation of endospores in two hyphae (× 444); *B*, appendages from the perithecial bulb (× 1111); *C*, ascospores in side view (× 2056); *D*, ascospores in optical cross section (× 2056); *E*, perithecium (× 231).

the cultural characteristics of the two colonies had remained unchanged during this period.

When grown on corn-meal agar and incubated for 72 hours at 28° C., colonies of *Chalaropsis* from date palm developed much more rapidly than similar colonies of *C. thielavioides* (FIG. 8). The palm fungus produced an abundance of macrospores during that period, while the other fungus formed only a few. The re-

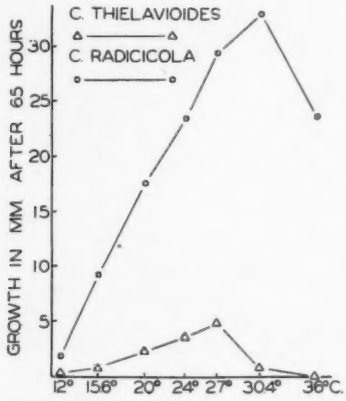

FIG. 9. Graph showing the growth-temperature relations of *Chalaropsis thielavioides* and *Ceratostomella radicicola*.

lation of temperature to mycelial growth was further investigated (FIG. 9) in another series of petri-dish cultures. Seven chambers were employed, with constant temperatures ranging from 12° to 36° C. It was found that the growth rates of the two fungi were markedly different, that the temperature range of the date-palm fungus was wider than that of *C. thielavioides,* and that the optimum temperatures varied about 3° C. Other differences (FIG. 10) were noticed in the appearance of the two fungi when grown at 10° and 28° C. At the lower temperature the endospores of both fungi tended to clump together in masses of slime, while at the higher temperature long chains of spores remained intact. The masses of endospores from the date-palm fungus were very large in comparison with those of *C. thielavioides.*

TABLE I

SIGNIFICANCE OF DIFFERENCES IN MEAN LENGTH AND MEAN WIDTH OF ASEXUAL SPORES OF *Chalaropsis thielavioides* AND *Ceratostomella radicicola* *

Culture	Endospores				Macrospores			
	Length (μ)		Width (μ)		Length (μ)		Width (μ)	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Ch. thielavioides, B-247	14.67	2.14	5.56	0.86	13.57	1.57	9.03	1.03
C. radicicola, B-261 . . .	11.82	1.74	7.70	0.25	18.08	1.77	13.33	1.44
Difference between means	2.85†		2.14†		4.51†		4.30†	

* Based on measurements of 120 spores each.
† Highly significant.

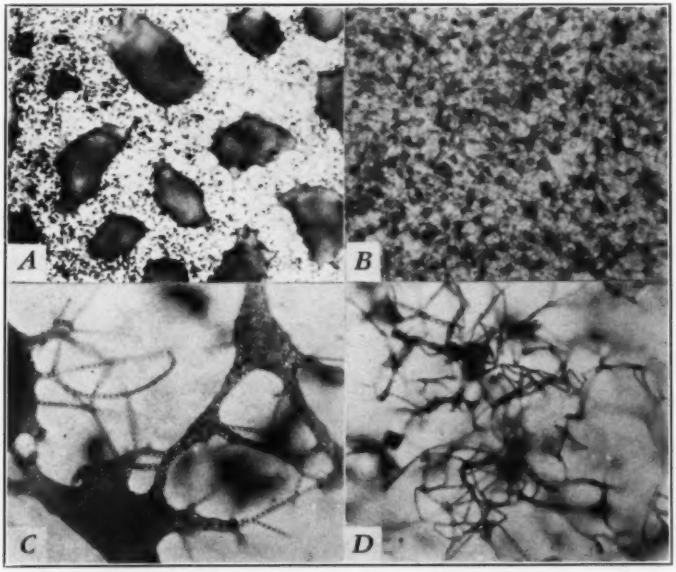

FIG. 10. Surface view of mycelial colonies, showing the effect of temperature on the tendency of the endospores to clump together in masses of slime. Cultures on corn meal agar, incubated for 72 hours; *A* and *B*, at 10° C. (× 28); *C* and *D*, at 28° C. (× 96). *A, C, Ceratostomella radicicola; B, D, Chalaropsis thielavioides.*

Studies were also made of the percentage distribution of different spore sizes (FIG. 11). The spores were taken from specially prepared petri-dish cultures on corn-meal agar, which had been incubated 20 to 25 days at 28° C. The measurements were made on a random sample of 120 spores in each case. When the

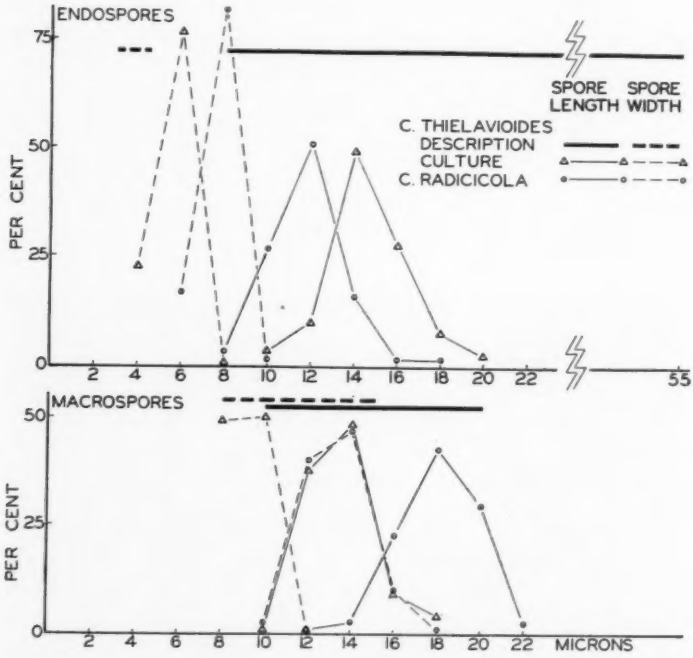

FIG. 11. Graphs showing percentage distribution of spore sizes of *Chalaropsis thielavioides* and *Ceratostomella radicicola*. Cultures were prepared on corn meal agar and incubated 20 to 25 days at 28° C. Each curve was based on the measurement of 120 spores. The heavy horizontal lines indicate the ranges of spore sizes as published by Peyronel (11) in his original description of *C. thielavioides*.

data for these distribution curves were treated statistically (Table I), the differences in the mean length and width of endospores and macrospores of the two species were found to be highly significant. All of these values were above the 1 per cent level of significance.

In other words, the probability that the difference was due to chance occurrence was less than 1 in 100.

In addition, the endosporophores of the date-palm fungus were found to be about twice as long as those of the type species.

Attempts to infect date palms with *Chalaropsis thielavioides* were unsuccessful. *Ceratostomella radicicola* was definitely parasitic on date palms but gave only slight evidence of pathogenicity on *Lupinus albus*.

DISCUSSION

The principal reason for erecting a new species for the fungus from date palm is that the perfect stage of this organism has been demonstrated. It has also been shown that the imperfect stage of this fungus differs in several ways from *Chalaropsis thielavioides*. Since no one has found an ascogenous stage associated with *C. thielavioides*, it would seem unwise to assume direct relationship with this new *Ceratostomella* unless the imperfect stages of the two could be shown to be identical.

Because of its attack upon the roots of the date palm, the new species has been named *Ceratostomella radicicola*. It is closely related to those species of the revised genus *Ophiostoma* H. and P. Sydow (**12**) and of the section *Longirostrata* Nannfeldt (**9**).

ACKNOWLEDGMENT

Appreciation is expressed for the assistance of Miss Edith K. Cash, who prepared the Latin description.

UNIVERSITY OF CALIFORNIA
CITRUS EXPERIMENT STATION,
RIVERSIDE, CALIFORNIA

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NOTES ON THE SYNONYMY OF FRENCH AND AMERICAN AGARICS—II

MARCEL JOSSERAND AND ALEXANDER H. SMITH

(WITH 4 FIGURES)

Since publishing the first number (**5**) in this series, our investigations have been continued in so far as circumstances permitted. The eight pairs of names considered in the following text represent only a few of the species we have studied critically. Our study of *Cantharellus clavatus* and *C. multiplex* does not form a contribution to synonymy, but rather the opposite. We include it here, and plan to include other similar studies in the future, whenever they clear up important points concerning the identity and validity of closely related species. In our investigations we are continuing to follow the rules which we outlined in our first report. Consequently, in many groups of agarics in which it is difficult to recognize species either in America or Europe, we are withholding the results of our studies until such time as more complete information is at hand. This usually involves more field work, and, of course, it is impossible to predict when, if ever, we shall be able to obtain the necessary information to complete a particular group. Such delays are common knowledge to agaric specialists, but are not always understood by investigators in other fields.

The question of the existence of "parallel species" in Europe and North America is most difficult to study. Without a doubt there will be found numerous instances in which a geographical distinction is correlated with some minor but characteristic and constant morphological difference. As more information accumulates, however, the evidence points to the conclusion that in North America at least both members of a pair frequently occur. Hence a geographical distinction can be made only after exhaustive field studies and then not with absolute certainty. In some cases the supposed differences which appear to establish the existence of parallel species in America and Europe are revealed to be due to

inaccurate or inadequate descriptions on the part of either European or American authors. These situations are the ones which we are particularly interested in clarifying. In so doing we do not imply that mycologists of either continent have been negligent or careless as a group. Negligence or carelessness, we believe, are individual characters found about as frequently in one region as another, and are to be deplored wherever found.

As careful microscopic studies of American agarics progress, one is amazed at the number of valuable taxonomic characters discovered which aid either in reducing so-called American species to synonymy or establishing them beyond any possible doubt. The mere discovery of a peculiar anatomical character, however, is frequently not the end, but only the beginning of an investigation. For instance, the discovery by Smith (**25**) that *Tricholoma fallax* (Peck) Sacc. has a pseudo-hymeniform layer of pear-shaped cells forming the cuticle of the pileus, and that there is a second species practically identical with Peck's in appearance which has a perfectly homogeneous pileus, has raised the question of whether Peck's name has been correctly used by various European authors. If *T. fallax* were known only from North America, and the other species only from Europe, a clear case of "parallel species" might be established. Since both occur in the same habitat at the same time of the year in the same region, no such claim can be made.

Situations like the above make it very difficult for investigators to evaluate correctly the species described by the early workers of Europe. In addition, it frequently happens that several modern interpretations of the older European species exist, and an investigator in some other part of the world, if he is to continue his study, is forced to choose between them. If one considers these difficulties on the one hand, and on the other the additional trouble caused by incomplete and erroneous descriptions, the need for a study such as we are carrying out becomes clear indeed.

It should be added here that our study has been greatly facilitated by the suggestive specific names which have been given to many of the species in question. Names which suggest or emphasize the distinctive character of a plant are of great aid to investigators seeking to discover relationships and synonyms.

In the descriptions given in the following text the color names

in quotation marks are taken from R. Ridgway, Color Standards and Color Nomenclature, Washington, D. C., 1912. The specimens cited by number have been deposited in the Herbarium of the University of Michigan.

COLLYBIA MYRIADOPHYLLA (Peck) Sacc.: COLLYBIA TELEOIANTHINA Metrod (FIG. 3, *a*).

In our first paper (**5**) we pointed out that *C. lilacea* Quél. was a synonym of *C. myriadophylla*. Even as we established this synonymy another was suggested. Metrod (**13**) published *C. teleoianthina* as a new species. Its characters were the same as those of *C. myriadophylla* except that Metrod gave the spores as 8–9 × 3–4.5 μ. Those of *C. myriadophylla* are smaller and shorter (3.5) 3.8–4.3 (4.6) × 2.4–3 μ.

Because of this apparently important difference, Josserand was led to make a careful study of dried specimens which he obtained from M. Metrod for this purpose. An examination of the specimens showed the spores to be 3.8–5.3 × 2.3–2.6 μ, and in close agreement with those of Peck's species. Thus the only difference disappeared, and it was evident that *C. teleoianthina* was a synonym of *C. myriadophylla*, to which Metrod concurred in a letter to Josserand Dec. 3, 1837.

CANTHARELLUS MULTIPLEX Underwood: CANTHARELLUS CLAVATUS Fries.

Although the situation in regard to these two species does not involve a contribution to synonymy, we wish to take this opportunity to clarify a point which at present is still somewhat confused.

Mounce and Jackson (**14**) reported *C. multiplex* from Quebec stating that they believed their report to be the first record of the fungus since its description. Shope (**20**) reported it from Colorado and published a photograph as well as a description which was based on the specimens he collected. He cited the report of Mounce and Jackson as the only other record besides the original description. Overholts (**16**) called attention to Kauffman's dis-

cussion of *C. multiplex* and to the latter's statement of its distribution in western United States. Kauffman (**8**) believed that *C. multiplex* was merely a growth form of *C. clavatus*. Povah (**18**) reported *C. multiplex* for Michigan in 1935.

Shope (**20**) found that the spores of his specimens were similar to those of the type, a fragment of which he examined. He described them on p. 347 as "hyaline, irregularly globose to globose ovate, 4–6 × 4–6 μ, tuberculate. . . ." If this spore size is compared with that of *C. clavatus*, in which the spores regularly measure 9–12 × 5–6 μ, an important discrepancy in both shape and size is at once apparent. This discrepancy led us to question Kauffman's disposition of *C. multiplex*.

An examination of Kauffman's collections of *C. clavatus* and *C. multiplex* revealed that both had the same spores, 9–12 × 5–6 μ. Shope very kindly gave the junior author a slide from the type of *C. multiplex*, besides material from his Colorado collection. The spores in both were found to be as Shope had described them. Sections of the pileus were revived in KOH and were observed to change quickly to blackish green. This reaction was demonstrated on the sections of the type as well as on the Colorado specimens. No such color change occurred on any of Kauffman's collections filed under either name. It is evident that here are two very distinct characters which will serve to separate herbarium specimens of these fungi. Obviously, Kauffman confused a very luxuriant form of *C. clavatus* with *C. multiplex*—a mistake which could be made very easily since both apparently have about the same stature and much the same coloration. Kauffman's comments on the distribution of the latter therefore apply to the former. Povah's collection was also examined. The specimens proved to be *Pleurotus porrigens*.

As a result of this study it becomes apparent that Shope was the first to correctly report *C. multiplex* from Colorado. We have used the older names for both species here. In Europe *C. clavatus* is now better known as *Neurophyllum clavatum* (Fries) Pat. Since neither of us has seen fresh specimens of *C. multiplex*, it would be inappropriate for us to attempt to solve the question of its generic position at this time.

FLAMMULA SCAMBA (Fries) Sacc.: NAUCORIA CAESPITOSA Murr. (FIGS. 1, *g* and *h*; 3, *b*).

Flammula scamba has had a somewhat troubled history. For many years, in fact until quite recently, it was considered to be very close to *Paxillus tricholoma* and to differ chiefly in its glabrous pileus and lack of a fringed margin. Konrad (**10**) considered them to be conspecific and was supported in this belief by Dr. René Maire. Kauffman (**7**) mentioned *Paxillus scambus* in connection with *P. alienus* and was obviously adhering to the concept that it was close to *P. tricholoma.*

Comparatively recently, however, this concept was questioned by both Kühner and Lange who had collected a fungus which was much more in line with the Friesian descriptions. This later concept is now the one generally accepted by European investigators including Konrad and Maire. It seems to be generally agreed that there is only one European species in the *P. tricholoma* complex. It is quite different from the fungus referred to *F. scamba* by Kühner and Lange.

Smith (**22**) reported *Naucoria caespitosa* from California in 1937. This identification was checked by an examination of Murrill's type, and no attempt was made to place the fungus in *Flammula.* Since that time, however, attempts have been made to find the species in the European literature. A study of the European species of *Flammula* immediately brought to light the similarity between Murrill's fungus and the *Flammula scamba* (Fries) Sacc. sensu Lange, Kühner, etc. A careful study satisfied the junior author that *N. caespitosa* was identical with *F. scamba* of the above authors, and that the Friesian descriptions applied remarkably well to it. In order to be certain, however, dried specimens, notes and photographs were sent to M. Josserand. He was also convinced that the two were the same, but since he had not seen fresh specimens of the European species, the American specimens were turned over to Dr. Robert Kühner, who was also convinced that the two were identical. He pointed out that the apices of the cystidia in *N. caespitosa* were usually slightly incrusted, a character not shown by Konrad & Maublanc (**11**). However, Kühner stated that he had frequently observed such an

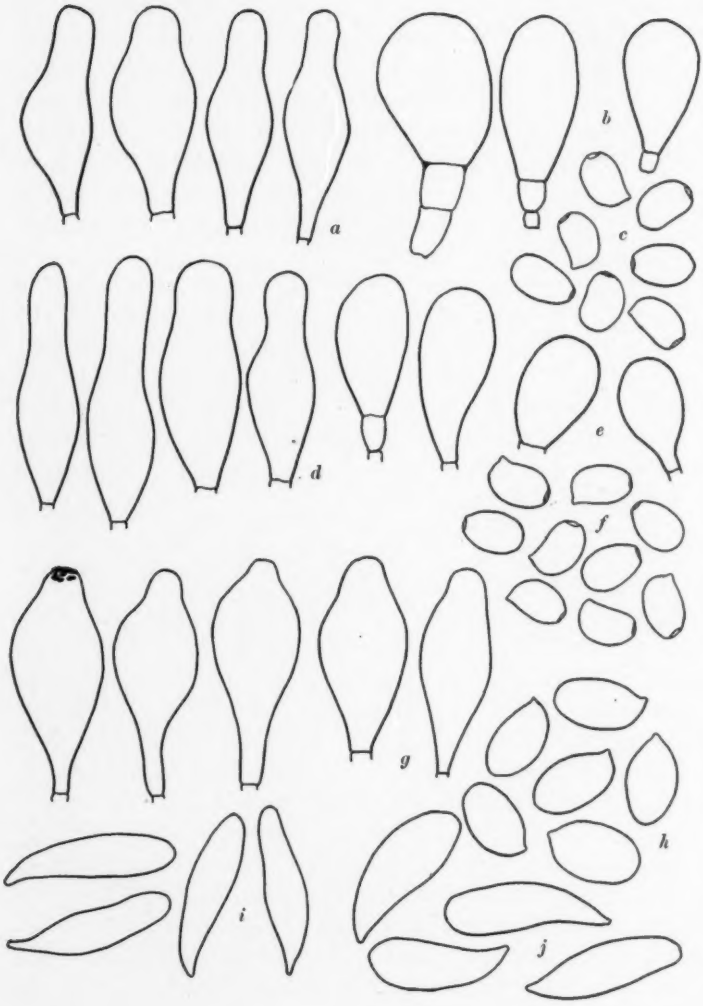

FIG. 1. Cystidia and spores of *Psathyrella hydrophila*, *Flammula scamba*, *Marasmius candidus* and *M. candidus* var. *setulosus*.

incrustation on the cystidia of his own specimens, and that consequently the presence of the encrusting material was not a difference between European and American specimens. Since there are no distinguishing characters, *N. caespitosa* should be regarded as a synonym of *F. scamba.*

In as much as this species has not been well known in North America, photographs of the fruiting bodies and drawings of the microscopic characters are given here along with a complete description. As the junior author has observed it in the western United States, it is more commonly densely gregarious than caespitose. It should also be found in northeastern United States and Canada.

Pileus 1–3.5 cm. broad, broadly convex or obtuse when young, becoming broadly convex to plane, with or without a low obtuse umbo, evenly "pinkish cinnamon" (pale buff) over all, surface at first covered by a mat of radially disposed fibrils which cause the margin to be fringed after the veil has broken, viscid when moist but soon dry, glabrescent, whitish in age; flesh very soft and watery, cartilaginous, sordid watery yellowish, odor not distinctive or faintly fragrant, taste none; lamellae close (26–32 reach the stipe), some forked near the base, in about three tiers, "cartridge buff" (whitish) in color, becoming sordid yellowish brown, moderately broad (3–3.5 mm.), tapering from the base to the margin or becoming slightly ventricose, horizontally adnate or developing a slight tooth, edges even; stipe short, 1.5–3 cm. long, 2–3 mm. thick, usually curved, equal, solid and fleshy, base with numerous "pinkish cinnamon" to whitish rhizomorphs and somewhat strigose at the point of attachment, lower three fourths densely fibrillose and peronate, the sheath soon broken up into floccose patches and eventually more or less disappearing, fibrils concolorous with those of the pileus, apex "sea-foam-yellow" (pale yellowish) and minutely squamulose, lower portion pale buff to somewhat yellowish.

Spores 7–9 × 4–5 μ, smooth, pale rusty brown under the microscope, subovoid, with a slightly thickened wall, apex not truncate; basidia four-spored; pleurocystidia abundant, hardly projecting beyond the hymenium, apices smooth or somewhat encrusted, ventricose in upper portion, abruptly narrowed to a broad rounded apex, with a distinct pedicel or sessile; cheilocystidia abundant, similar to pleurocystidia; gill-trama with a floccose central strand flanked on either side with narrow subgelatinous hyphae (which

appear glassy in KOH); pileus-trama homogeneous beneath a layer of brown-walled (in KOH) hyphae which are subgelatinous.

HEBELOMA SARCOPHYLLUM Peck: HEBELOMA PORPHYROSPORUM R. Maire.

In 1872 Peck described a *Hebeloma* which was unique in having reddish-incarnate gills and spores distinctly reddish in mass. Kauffman included the species in his Agaricaceae of Michigan and reëmphasized its unique characters. He reported it as infrequent. In 1931, Dr. R. Maire published *Hebeloma porphyrosporum*, a mushroom having the same outstanding characters as Peck's species.

Josserand, comparing the two descriptions, suggested that the species in question were conspecific. He had had an opportunity to study *H. porphyrosporum* in the fresh condition. The specimens were sent to him by Marcel Locquin and had been collected at Lentilly, near Lyon. Smith had collected *H. sarcophyllum* in Michigan so a joint study of both species was undertaken.

Three differences at first seemed to separate them. First, the pileus of *H. sarcophyllum* is paler than that of Maire's species. Peck described the pileus of his fungus as white, Kauffman (**6**) described it as "chalk white becoming dingy white." In his field notes Smith described it as white but soon becoming reddish gray. Maire (**12**) described *H. porphyrosporum* as follows: "cutis . . . albida disco rufo-ferrugineo suffusa, demum rufo-ferruginea, albido-marginata." In his study of *H. porphyrosporum*, Josserand noted "chapeau allant de creme-ivoire a beigeasse, a incarnat, a ocrace-incarnate, a ocrace-rosatre." This constitutes a difference, albeit a slight one.

Second, Peck did not indicate any cortina in his description. Kauffman (**6**) p. 480 stated "there is no cortina," and Smith in his notes stated "veil slight." Maire for his species noted "cortina alba" but added "fugacissima."

Third, there appears to be a slight difference in spore size. A study of Peck's type revealed that the spores measured 7–9 (10) × 4–5 μ. From a spore-deposit of a Michigan collection, Smith found the spores to be 8–10 × 4.5–5.5 μ. Kauffman gave the spores of Peck's species as 9–12 × 5–6 μ, somewhat larger than

in Peck's type. Smith, in studying Kauffman's collections found the range to be 9–12 (13) × 5.5–7 μ. Maire described the spores of his species as 11–15 × 5–6 μ. Josserand upon examining Maire's type found the average spore-size to be 11.2 × 6.6 μ. Those from M. Locquin's collection were 10.2–11.5 × 6.2–6.8 μ.

Since a difference in spore-size is the most significant character we discovered, we attempted to separate our various collections on that basis. A length of 10 μ appeared to be the dividing line. In Peck's species, on that basis, we would have the type and Smith's Michigan collection with a range below 10 μ, and all the other collections, including Kauffman's Michigan material, would have to be placed in Maire's species.

On the basis of a difference in spore-size, the slight color differences noted above and the supposed presence or absence of the cortina do not correlate. If primary emphasis were placed on either the color or the cortina, one still could not obtain a correlation. In view of the experience each of us has had in our own collecting grounds, we believe that the differences of color and development of the cortina are secondary characters very easily influenced by local conditions, and that since these differences between the two species under consideration are very slight, they should be regarded as simple variation.

The difference in spore-size may be significant, but here more data are needed to establish it. Actually very few collections of either species have been critically studied. In the genus *Mycena*, *M. amicta* and *M. subcaerulea* are recognized on the basis of a difference in both size and shape of their spores. In *M. capillaripes* and *M. haematopus*, Smith has observed differences in spore-size as great as that given above without attaching any particular taxonomic importance to them. Arnold (1) has studied a similar series of differences in *Marasmius elongatipes* Peck. She concluded from a study of mating reactions that the long-spored and short-spored forms, since they were interfertile, were best classified within the one species. In *Cortinarius*, where spore-size is used as a very important character, the difference we have noted between the two species of *Hebeloma*, if correlated with another difference, would be considered significant. However, in the hebelomas under consideration there is no correlated difference.

Consequently we believe that the character is not taxonomically significant and hence consider *H. porphyrosporum* to be a synonym of *H. sarcophyllum.*

MARASMIUS CANDIDUS Fries: MARASMIUS MAGNISPORUS Murr. (FIG. 2, *a*, *b*, and *c*).

Overholts (**16**) recently published a photograph and description of *M. magnisporus* Murr. As a result of this account and conversations with Overholts at the time of the foray of the Mycological Society in 1939, the junior author was able to identify a group of collections which had puzzled him a long time. The senior author recognized in Overholts' description and illustration a species well known to him in France as *M. candidus* Fries sensu Quél. Since Josserand had already sent specimens of *M. candidus* to Smith, the latter was able to make a critical study of the species in spite of conditions imposed by the war. In his communication, Josserand indicated that he believed that *M. candidus* sensu Quélet, Bataille and Boudier and *M. candidus* Fries were all conspecific with *M. candidus* sensu Hard (**4**) and *M. magnisporus* Murr. sensu Overholts. Since Hard gave the spore-size as $4 \times 2\ \mu$, his account cannot be considered further in connection with *M. magnisporus.*

In proceeding with a critical study of this situation, the junior author first compared the type of *M. magnisporus* with the material sent to him by Josserand. A study of small pilei in Murrill's type revealed that cheilocystidia and pleurocystidia were absent—Overholts stated " cystidia none " in his description. In the largest specimen examined, however, numerous cheilocystidia 60–150 × 6–9 (11) μ were observed. In a few specimens the cheilocystidia were 30–50 × 6–11 μ, but showed a tendency to elongate. From this it was apparent that the cheilocystidia remain buried in the hymenium for some time and then elongate rapidly as the fruiting bodies near maturity. It should be noted here that in this species many small pilei usually accompany the larger individuals on a single stick. This character was well shown in Murrill's type. In studying the latter, all the fruiting bodies, both large and small, were taken from the same group in order to avoid possible errors. No pleurocystidia were observed on the older pilei of the type, but

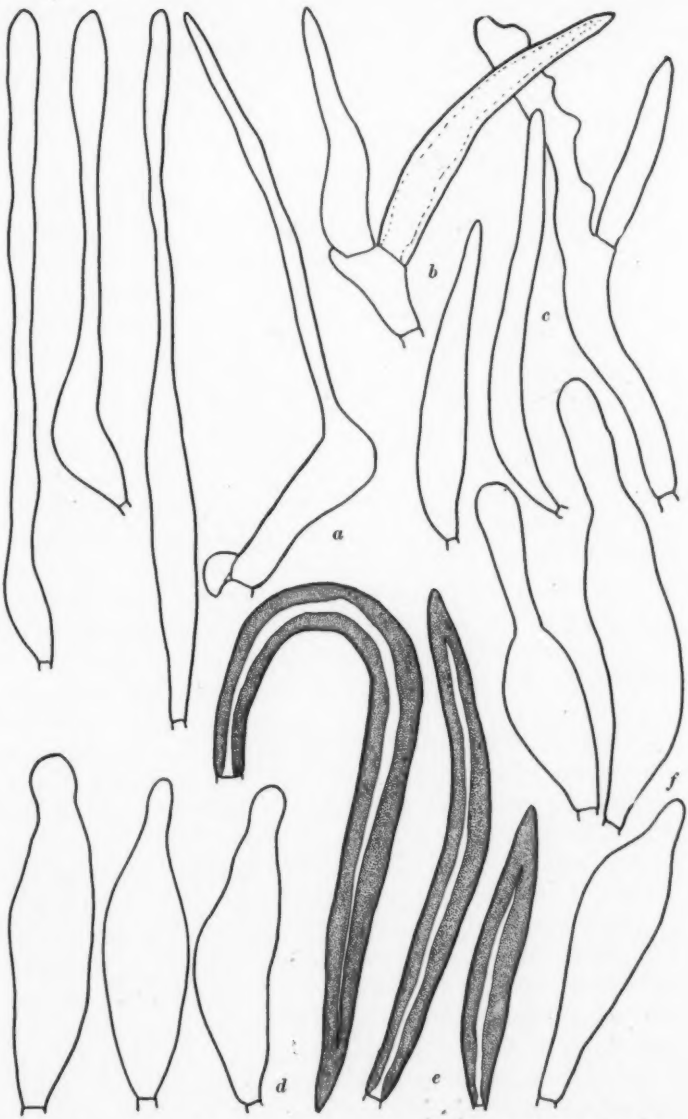

FIG. 2. Cystidia and setae of *Marasmius candidus* and *M. candidus* var. *setulosus*.

the pileus-trama appeared quite distinctive. The trama itself is of very loosely interwoven hyphae which are not at all gelatinous in consistency. Over the surface one finds a tangled mass of more or less elongated cystidia-like or greatly elongated hyaline cells some of which have slightly thickened walls. These do not form any sort of organized surface-covering. When young they are more or less upright and doubtless cause the pruinose appearance of the immature caps. In age they form a tangled, appressed, thin covering which, under a lens, appears finely fibrillose. The spores of the type were very variable in size, (10) 12–16 × 4.5–6 μ, and yellowish in iodine, as were all the tissues of the fruiting body. No brown-walled setae were found on the pilei though a special search was made for them.

Specimens from Josserand lacked the cheilocystidia but did have the same type of pileus-covering as that described above for Murrill's type. The spores were the same size and the dried fruiting bodies were indistinguishable. Both clearly showed the habit so well illustrated by Boudier (**2**). Since all of the pilei were rather small, the absence of cheilocystidia in the specimens from France is not a serious discrepancy in view of the above observations on Murrill's type. As a result of this study it was evident that Murrill's and Josserand's material represented the same species.

The junior author, however, had an accumulation of twelve collections from various parts of North America which complicated the situation. Eight of his collections from the Pacific coast checked well with Murrill's species except that pleurocystidia were sometimes present, particularly near the edges of the gills. In four of his collections from the Great Smoky Mts. National Park in Tenn., brown, thick-walled setae were found scattered over the surface of the pileus and pleurocystidia were generally abundant.

Among Kauffman's collections there is one identified by him as "*Marasmius candidus* Bolt." which is characterized by the brown setae on the pileus. It also has the abundant pleurocystidia and the narrow spores. Smith has been unable to demonstrate the presence of such setae on the specimens of *M. candidus* from France. An examination of Kauffman's notes showed that he had not observed the setae and had based his identification on Ricken's account of *M. candidus*. The hyaline pilocystidia ob-

served on the specimens from France and on Murrill's type were also present on the pilei of specimens possessing setae. A careful study of the western collections showed that they possessed occasional thick-walled hyaline or faintly yellowish setae as well as the thin-walled cystidia. In the search for setae on his specimens, Smith found it helpful to use lower magnifications when examining entire pilei and the usual high magnifications for examining sections. Under the former, the brown-walled setae showed up very well and their relative abundance on different pilei from the same or different collections was easily ascertained. Their distribution over a single pileus was found to be uneven and the number varied considerably in different pilei.

The disposition to be made of the southern collections involves the question of which of the conflicting concepts of *Marasmius candidus* of European authors should be accepted. Josserand wrote as follows on this point: I have made two notations concerning the *M. candidus* of authors: *M. candidus* sensu Pat. (Tab. Anal. Fung.) is surely not *M. candidus* of Fries. It is most certainly *Delicatula integrella!* I showed the plate to Kühner without telling him my opinion in order not to influence him, and he also stated emphatically that it was *D. integrella. M. candidus* sensu Lange (Fl. Agar. Dan.) is not *M. candidus* Fries, but probably *M. languidus* (translated from Josserand's letter of May 13, 1940).

Without question the concept of Quélet, Bataille and Boudier is the European concept most closely in line with the Friesian descriptions. However, the Friesian descriptions apply equally well to either of the American forms. In North America, before Murrill described *M. magnisporus,* fungi of this type were generally referred to *M. candidus* Fries, see Kellerman (**9**). Kauffman, to judge by his notes, also had accepted the European concept mentioned above. Thus the *M. candidus* of the French authors and that of certain American investigators is the same. Since this concept is perfectly in line with the Friesian description, we believe it is the one which should be generally adopted, and are thus forced to consider Murrill's name as a synonym of *M. candidus.*

For the collections characterized by the brown setae we propose the following variety:

Marasmius candidus var. **setulosus** var. nov. (FIG. 1, *i*; 2, *d*, *e*, and *f*).

Pileus albidus, setulosus; setae aciculares, ferruginosae, 40–200 × 6–10 μ; pleurocystidia 32–56 (100) × 8–15 μ, ventricosa vel subcylindrica; sporae (10) 12–14 × 3–4.5 μ.—Specimen typicum in Herb. Univ. of Mich. conservatum: legit prope Elkmont, Tenn. Aug. 8, 1938, A. H. Smith n. *9943*.

Pileus (5) 10–20 (25) mm. broad, convex to umbonate or nearly plane in age, the margin usually irregular and wavy, pure white, appearing glabrous, very thin, white, striate, becoming plicate in age or rugulose, soft and fragile (but drying rigid and reviving well), odor and taste none; lamellae white, very narrow, adnate, becoming free in age, distant, the short individuals reduced to veins and often the interspaces decidedly intervenose; stipe 1–2 cm. long, 1.5 mm. thick, equal or slightly enlarged above, short, terete, usually eccentric, white above, becoming blackish toward the base, appressed fibrillose to minutely pubescent, apex faintly silky, sometimes slightly striate, base rather conspicuously pubescent or surrounded by white mycelium.

Spores (10) 12–14 × 3–4.5 μ, hyaline, narrowly drop-shaped, yellowish in iodine; basidia four-spored; pleurocystidia and cheilocystidia similar, 32–56 (100) × 8–15 μ, irregular in shape, more or less fusoid-ventricose to cylindric, hyaline, smooth; gill-trama homogeneous, yellowish in iodine; pileus-trama homogeneous, loosely floccose, not gelatinous, with brown, thick-walled setae 40–200 × 6–10 μ scattered over the surface in addition to hyaline cystidia.

Singly to gregarious on sticks and debris of hemlock and tuliptrees, Tennessee and North Carolina.

When more is known of both the species and the variety, it will probably be discovered that the present apparent geographical distinction will disappear, and, that, like *Tricholoma fallax* and its counterpart, both occur in close proximity to each other during the same season. It is possible that the variety differs from the species in having a slightly different habit and slightly narrower spores in addition to the setae and pleurocystidia. These characters are likely to vary considerably however, and we do not wish to emphasize them without first examining a larger series of specimens. Since the junior author did not detect the difference between the variety and the species in the field, his observations on the fruiting bodies he has seen in central and southern United States, but not collected and preserved, are of no value.

In western United States, where only *M. candidus* has been collected, it has been found very abundantly, particularly in the Humid Transition life zone. In the dense thickets of elderberry and various species of *Rubus* along the coast a few miles south of the tip of Cape Flattery, Wash., where the canes of species of *Rubus*

FIG. 3. Above, *Collybia myriadophylla* Peck × 1; below, *Flammula scamba* (Fries) Sacc.

attain a length of six to ten or twelve feet, specimens have been collected which measured 3–4 cm. across the pileus. These collections were lost in an accident. In collection no. *9496* from Crescent City, Calif., the largest specimen measured 3.5 cm. broad. This collection was from alder (*Alnus rubra*). Josserand reports that he has observed a variation of from 3–25 mm. in the size of

the pileus. One of the striking features of *M. candidus* is the large number of abortive fruiting bodies which are produced even under conditions which favor the development of the largest specimens cited above.

Smith's specimens confirmed the observations made by Overholts on the thickness of the stipe. In some the stipe is thickened above, but one is just as likely to find it equal.

MARASMIUS CHORDALIS Fries: MARASMIUS LIMONISPORA Kauff.

In 1925 Kauffman (**8**) described a *Marasmius* collected on the slopes of Mt. Hood, Ore., as *M. limonispora*. In addition to the somewhat ventricose spores, the species was characterized by having the stipe entirely pruinose, and in having cystidia on the faces and edges of the gills. After reading the description, Josserand believed that it could apply equally well to the previously described *M. chordalis* Fries and suggested this pair of names to the junior author as a subject for critical study. The study and discussion which followed was facilitated by the fact that both of us were familiar with *M. chordalis*.

Specimens reported as *M. chordalis* by Smith (**23**) were studied by Josserand who was convinced that the American material was the *M. chordalis* of Patouillard, Kühner and Josserand, Bresadola etc. Comparisons between the *M. chordalis* of the above authors and the Friesian descriptions brings out certain minor differences. Fries did not mention that the gills frequently stain reddish in age. However, Singer, who also knows this species, has examined dried specimens prepared by Robert Fries which were recognized as authentic by Elias Fries and found them "exactement identiques" with the *M. chordalis* of Kühner and Bresadola.

After verifying our concepts of *M. chordalis* we proceeded to a critical study of *M. limonispora*. Particular attention was given to the size and shape of the spores, the abundance, size and shape of both pleuro- and cheilocystidia, the nature of the cuticle covering the pileus and the type of pubescence covering the stipe. Kauffman's specimens were found to have the typical pseudo-hymeniform palisade of cells forming the cuticle of the cap and some of these were observed to have elongated at the apex to a filiform

appendage thus giving them the appearance of cystidia. Their presence causes the pilei of fresh specimens to appear pruinose. The pleurocystidia and cheilocystidia were also found to be similar in size, shape and abundance. The spores of both were found to be similar in shape and size and to become yellowish in iodine. In view of this evidence, we believe that *M. limonispora* should be regarded as a synonym of *M. chordalis.*

PSATHYRELLA HYDROPHILA (Fries) Smith: HYPHOLOMA CALIFORNICUM Earle. (FIG. 1, *a, b, c, d, e* and *f;* 4)

Psathyrella hydrophila is a common species both in France and the United States. Depending on the weather, it can be found on or around the wood and debris of hardwoods from midsummer to late fall. It has been fairly well characterized both in Europe and North America so a detailed description is not given here. There are several species which could be confused with it very easily. These are *P. madeodisca* (Peck) Smith, *P. chondroderma* (Berk.) Smith and *P. oblongispora* (Parker) Smith. Critical studies of these have been published, see Smith (**24**).

Parker (**17**) gave the distribution of *P. hydrophila* (*Hypholoma hydrophilum*) as extending from New York to Florida and west to Pennsylvania. The records in the University of Michigan Herbarium at the present time include material from Nova Scotia, New York, Maryland, Tennessee, Ontario, Michigan, Washington, Oregon and California. During the course of identifying his collections from California the junior author had occasion to consider a species described by Earle, *Hypholoma californicum.* A study of the type, C. F. Baker, no. *86,* was made. The study brought to light some interesting information.

Parker (**17**) recognized *H. californicum* as distinct from *H. hydrophilum* but gave no comments suggesting a close relationship. Since he (p. 206) reported *H. californicum* as occurring in conifer forests, it is possible that he regarded this a distinction between them. It is difficult to understand where Parker obtained his information. The original description by Earle (**3**) p. 344, states that *H. californicum* is " Densely caespitose on or near the base of oak stumps." This accurately describes both the habit and habitat

of *P. hydrophila.* In his study of the type of Earle's species the junior author found the spores to be as Earle described them, 5–6 × 3 μ. The blunt pleurocystidia were almost identical with those found on a specimen of *P. hydrophila,* which was communicated to the Univ. of Mich. Herbarium by Josserand. The characteristic layer of vesiculose cells which forms the cuticle of the pileus in these fragile dark-spored agarics was also similar in

FIG. 4. *Psathyrella hydrophila* (Fries) Smith, slightly reduced.

both. The dried fruiting bodies of both were identical in appearance and consistency. However, since dried specimens in the genus *Psathyrella* all look very much alike and have the same consistency, this similarity is not as important as that between their microscopic characters. From this study it was apparent that the two were conspecific. This information along with camera-lucida drawings of the spores and cystidia was communicated to Josserand. Because of the outbreak of the war our correspondence was carried out largely by air mail and a further exchange of

specimens was not practical. After satisfying himself that Earle's species was not the same as *P. chondroderma,* the senior author agreed that *H. californicum* was not distinct from *P. hydrophila.*

Although this species is most sharply characterized by its microscopic characters, certain points concerning its gross features are pertinent to this study. The stipe of *H. californicum* was described as "uneven with small irregular swellings, sordid white, marked with brownish stains on drying." This suggests a similarity to *P. chondroderma.* In the latter, however, the stipe discolors as the fruiting body matures or ages. Stains such as Earle described are likely to appear on any species of *Psathyrella* as the specimens dry. The unevenness of the stipe is a secondary character which the junior author has found to be quite common with a number of species closely related to *P. hydrophila* and which was quite evident on the specimens illustrated in figure 3.

The colors of the moist pilei are quite variable in North American material. They are generally given as cinnamon brown to chestnut brown, and this is the range most commonly observed. However, specimens with very dark dull brown pilei ("mummy brown") occur as well as others with a more vinaceous cast ("verona brown"). The same general range of color variation observed for *Stropharia longistriata* Murr., see Smith (**24**), has been observed for *P. hydrophila.*

A certain amount of variability has been observed in the microscopic characters also. The spore-size though constant and distinctive varies somewhat. Measurements from a number of North American collections read as follows: 4–5 × 2.5 μ; 4–5 × 2.5–3 μ; 4.5–5 × 3–3.5 μ; 5–6 × 3–3.5 μ; 4.5–6 × 3–3.5 μ; Josserand has noted that in his spore-deposits the measurements are 5.6–7.6 × 3.2–4.1 μ. In his dried specimens however, they measure 5–6 × 3–3.5 μ. Ricken (**19**) has given the spore-size as 5–6 × 2–3 μ. The most interesting feature brought out by these measurements is that the spores of *H. californicum* are almost identical in size with the material from France whereas most of the collections from other parts of North America have spores which consistently range a bit smaller.

Kauffman (**6**) under *Hypholoma hydrophilum* sense of Ricken described the cystidia as "few or none." Smith has examined

Kauffman's specimens and found the pleurocystidia to vary in abundance. On certain collections from Ann Arbor they are very abundant and on others they are scattered to rare. Finally, the junior author's own collections have shown the same degree of variability in this character. The very obtuse apices of the pleurocystidia are their most important diagnostic feature.

Since we have not been able to find any character of recognized taxonomic value by which *H. californicum* can be distinguished from *P. hydrophila,* we have no hesitation in referring it to the latter as a synonym.

PHOLIOTA ERINACEA (Fries) Quél.: NAUCORIA BADIA Murr.

Naucoria badia was described from near Seattle, Wash. and has apparently not been recognized since from other regions in North America. During the summer of 1936 the junior author made a critical study of it while collecting with Prof. H. S. Jackson in the Lake Timagami region of Ontario, Canada. Since 1936 the type of *N. badia* has been critically studied and the Timagami material compared with it. The two were found to be identical. Prof. Jackson has found the fungus regularly for a number of years on twigs of hazel-nut bushes and of birch on Bear Island in Lake Timagami. The following description is based upon collections made on the island during the season of 1936.

Pileus 5–15 mm. broad, usually convex, sometimes slightly depressed on the disc or the disc slightly umbonate, surface dry and densely covered by fibrillose scales, the scales erect and almost spine-like on the disc, somewhat appressed toward the margin, the margin fimbriate with over-hanging fibrils, color "auburn" "russet" or "ochraceous tawny" (dark rusty brown to tawny), paler and more yellowish along the margin; flesh thin and fairly tenacious, pallid brownish, becoming whitish, odor not distinctive, taste not recorded; lamellae close to subdistant, broad, bluntly adnate, whitish, becoming pinkish-cinnamon or darker; stipe 8–15 mm. long, 1–2 (2.5) mm. thick, equal or the base somewhat enlarged, stuffed by a narrow pith, pliant and tough, lower portion densely squarrose scaly with fine fibrillose scales, somewhat silky above the fringe left by the broken veil, pallid brownish above, dark rusty red below.

Spores ellipsoid to subovoid, 7–9.5 (10) × 4–5.5 (6) μ in water-mounts of fresh material (slightly broader when revived in KOH), smooth, thin-walled, many collapsing, pale yellowish brown under the microscope in KOH; basidia four-spored; pleurocystidia none seen; cheilocystidia fusoid ventricose to filamentose, elongating and frequently branching in age, 20–35 × 6–9 μ; gill-trama homogeneous; pileus-trama with a surface layer of long, brown, thick-walled hyphae 5–7 μ in dia., and having free somewhat pointed tips, these hyphae septate and regularly with clamp connections, the remainder of the trama homogeneous.

A characteristic feature of this fungus is that the surface hyphae of the pileus in mounts of revived material either do not break up or if they do, they break up into long cylindric lengths usually the size of a single cell. The spores have a tendency to collapse quite readily and to become over-inflated when revived in weak KOH. Josserand has noted this same tendency in the spores of *Pholiota erinacea* of France.

If the above description is compared with that of *Pholiota erinacea* (*Naucoria* or *Phaeomarasmius* of some authors), a very striking resemblance is noted at once. American material was sent to M. Josserand who in return sent complete data including specimens to the junior author. We both arrived at the same conclusion, namely that the two were the same. However, one discrepancy was noted. In the European material the spores measure 8.5–11 × 6.5–8.5 μ and its basidia are one or two-spored. The American material so far examined has been consistently four-spored. It is apparent that here we are dealing with a simple variant-form comparable to those found frequently in the North American species of *Mycena* by Smith (**21**), and, as in *Mycena,* the difference in spore size which accompanies the change from the usual four-spored condition is not a taxonomically significant difference. *Naucoria badia* must therefore be regarded as a synonym of *Pholiota erinacea.*

SUMMARY

In the preceding account one new variety, *Marasmius candidus* var. *setulosus,* is described, and *Cantharellus multiplex* has been

reëstablished as a species distinct from *C. clavatus*. The following contributions to synonymy have been made:

1. *Flammula scamba* (Fries) Sacc. (= *Naucoria caespitosa* Murr.)
2. *Hebeloma sarcophyllum* Peck (= *Hebeloma porphyrosporum* Maire)
3. *Marasmius candidus* Fries (= *Marasmius magnisporus* Murr.)
4. *Marasmius chordalis* Fries (= *Marasmius limonispora* Kauff.)
5. *Pholiota erinacea* (Fries) Quél (= *Naucoria badia* Murr.)
6. *Psathyrella hydrophila* (Fries) Smith (= *Hypholoma californicum* Earle).

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DESCRIPTION OF FIGURES

The drawings were made with the aid of a camera-lucida and as reproduced the cystidia are approximately 980 × and the spores 1500 × natural size.

FIG. 1. *P. hydrophila* from Josserand, Lyon, France, *a*, pleurocystidia; *b*, cheilocystidia; *c*, spores. *H. californicum* (type), *d*, pleurocystidia; *e*, cheilocystidia; *f*, spores. *Flammula scamba*, *g*, pleurocystidia and *h*, spores. *Marasmius candidus* var. *setulosus*, *i*, spores. *M. magnisporus* Murr. (type); *j*, spores.

FIG. 2. *Marasmius magnisporus* Murr. (type), *a*, cheilocystidia, *b*, cystidia from the surface of the pileus. *M. candidus* var. *setulosus*, *d*, cheilocystidia; *e*, setae from the pileus, *f*, pleurocystidia.

A NEW POLYPORE IN WASHINGTON

ELIZABETH EATON MORSE

(WITH 5 FIGURES)

A stipitate polypore was observed and studied by Mr. J. B. Flett in Bremerton, Washington, from 1931 to 1939. It was first noticed because of its stature (up to 17 cm. tall), its exceedingly brittle and hygrophanous tissues and the bluish-green [1] coloration of the pilei.

Bremerton, as is well known, is located on a peninsula in sheltered Puget Sound, is well wooded and is subject to the heavy precipitation and dense fogs which prevail in that region. This fungus grew close to Mr. Flett's cabin in a more or less open *Pseudotsuga* forest, hence he was able to observe it day by day at all stages of development. It always appeared during the rainy seasons, though there were early and late arrivals in the months of September and March respectively. It grew in a thin layer of black humus 3 to 4 inches deep, unattached to living or decaying forest trees. This layer rested upon a deep substratum of sand and gravel, no clay present.

Mr. Flett watched an irregular Fairy Ring developing under cover of *Gaultheria, Vaccinium, Berberis* and *Rhododendron*. It advanced slowly where the vegetation was tall and dense, about 2 feet per year, but more rapidly on the open side of the ring—until a diameter of 75 feet was attained.

This fungus prospers best in semi-shade and when supplied with abundant moisture; the pilei become very brittle and snap like the crisp vein of a lettuce leaf!

The following description has been prepared from abundant material, extended correspondence, photo prints and the detailed notes supplied by Mr. Flett.

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[1] Aerugineus, Saccardo's *Chromotaxia*, no. 37, 1894.

Polyporus Flettii sp. nov.

Pileus circular or irregular by compression, crenate, undulate, 20 × 15 cm. broad in large specimens, at first convex, inrolled, later becoming plane and finally depressed at center; color when young greenish-blue, paler at margin, when dry becoming grayish or hoary, and finally dingy ochraceous; context white, 2 mm. thick at the margin increasing to 15 mm. at the center. Hymenium very shallow, separable from the context, pure white at first, becoming apricot to salmon when mature or dried, decurrent and ending in a reticulation on the stipe; at first covered with a spongy "superficial hyphal layer not involved in the process of tube formation," L. O. O.; tubes 1–4 to a mm., 1 mm. deep at margin to 7 mm. towards the stipe, mouths of tubes angular, not uniform; dissepiments dentate, becoming lacerate, finally fimbriate. Stipe smooth beyond the reticulation, white, solid, confluent with pileus, becoming dingy ochraceous when dry, up to 14 cm. long by 2–3.5 cm. wide, usually eccentric, often crooked from meeting obstructions or from caespitose manner of growth. Odor and taste farinaceous. Reported edible by Mr. Flett. Basidia clavate 12–16 × 4–6 μ, 4-spored; spores ellipsoid to subglobose, smooth, hyaline, uniguttulate, 3.5–4 × 2.5–3 μ. Cystidia and setae none.

Type locality. Bremerton, Washington, not reported elsewhere.

Habitat. In shallow black humus of mixed forest, even in gravel and moss.

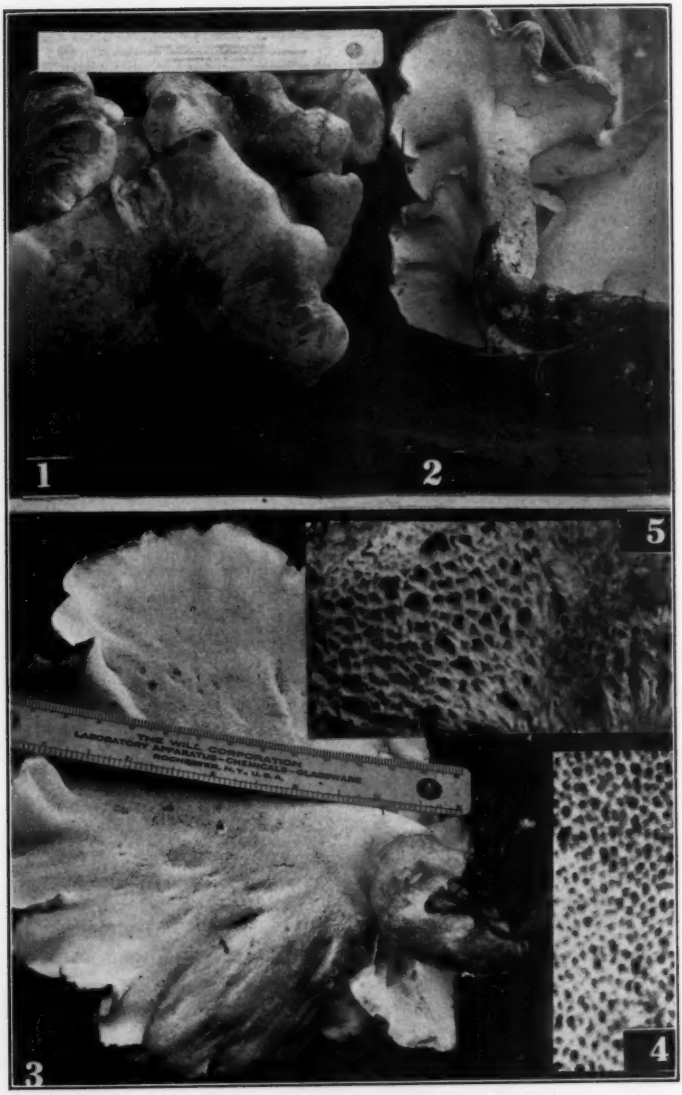
Habit. Gregarious, solitary, or caespitose.

Season. The rainy season, September to March.

Type collection deposited in Herbarium of the University of California as no. *589805*.

It is the opinion of L. O. Overholts that this fungus should be described as a new species (letter, May 25, 1936). Carleton Rea, England, comments as follows: "I do not know any species in England that will answer to your specimen" (letter, June 12, 1938). W. H. Snell writes: "Your fungus is without doubt a polypore and not a bolete. Separability of tubes is of no import even in the Boleti" (Feb. 3, 1941).

Grateful acknowledgments are made to Mr. Flett, as previously stated, and to those who examined specimens inclusive of Doctors Bonar, Overholts and Snell and Mrs. V. M. Miller. The writer



FIGS. 1–5. *Polyporus Flettii.*

earnestly hopes that other discoveries may be made and that opinions concerning this Washington polypore may be received.

CALIFORNIA MYCOLOGICAL SOCIETY,
UNIVERSITY OF CALIFORNIA,
BERKELEY, February 4, 1941

EXPLANATION OF FIGURES

FIGS. 1–5. *Polyporus Flettii* Morse: 1, Cluster of young sporophores, caps glabrous showing "bloom" easily marred, margins pale, crenate. 2, Under side of young sporophores, margins inrolled, hymenia covered with pure white spongy hyphal layer, mouths not yet opened out; stipes elongated, enlarged at bases, closely adjacent but not grown together. 3, Mature sporophore, margin expanded, thin, crenate, undulate; hymenial surface uneven, mouths opening out through hyphal layer; stipe elongated, ventricose. 4, Portion of pore surface enlarged, mouths open, shreds of hyphal layer intact. 5, Pores more enlarged, mouths angular, not uniform, dissepiments dentate, some lacerate, the most mature, fimbriate.

PEZICULA CARNEA AND PEZICULA SUBCARNEA [1]

J. WALTON GROVES [2]

(WITH 6 FIGURES)

A number of species of *Dermatea* and *Pezicula* have been reported at various times as occurring on *Acer*. Two of these species, *Dermatea acerina* (Peck) Rehm and *Pezicula acericola* (Peck) Sacc., were recently described in detail by the writer (**1938**). Subsequently a third species, *P. carnea* (Cooke & Ellis) Rehm, was collected in abundance on *Acer rubrum* at the Mycological Foray held at Duchesnay, Que., in 1938. Studies based on cultures obtained from this material and from a collection made by Dr. L. O. Overholts at McKeever, New York, have confirmed the opinion expressed in the above-mentioned paper, that this species is distinct from *P. acericola*.

In addition to these a *Pezicula* has been collected on *Acer pennsylvanicum* in the Gatineau district north of Ottawa and in the Temagami Forest Reserve, Ontario, which is similar to *P. carnea* in gross appearance but differs in having much larger asci and ascospores and slightly larger conidia. This fungus does not agree with any of the species previously reported on *Acer* and is, therefore, described as new.

Cultures were obtained from both ascospores and conidia in each species and were grown on two per cent malt extract agar and on sterilized twigs of the host. The cultures from ascospores and conidia were similar in each species and both produced the same type of conidial stage in culture.

PEZICULA CARNEA (Cooke & Ellis) Rehm, Ber. Bayer. Bot. Ges. **13**: 199. 1912.

Dermatea carnea Cooke & Ellis, Grevillea **5**: 32. 1876.

[1] Contribution No. 665 from the Division of Botany and Plant Pathology, Science Service, Department of Agriculture, Ottawa, Canada.

[2] Graduate Assistant, Central Laboratory, Ottawa.

Dermatea simillima Ellis & Ev. Proc. Acad. Phila. **1893**: 451. 1894.

Dermatea carnea f. seriata Rehm, Ann. Myc. **9**: 1. 1911.

Dermatea quercina f. Aceris Rehm, Syd. Myc. March. *1579*. 1887.

Apothecia erumpent, gregarious to scattered, or more or less in rows, separate or in small clusters, at first rounded, then cylindrical, finally expanding at the tip into a circular disc, sessile, narrowed below, 0.3–0.8 mm. in diameter, 0.3–0.5 mm. in height, brittle, waxy in consistency, becoming more fleshy when moist; hymenium at first concave, becoming plane to slightly convex, slightly pruinose when dry, "light pinkish cinnamon" to "cinnamon," becoming brighter when moist, "light ochraceous buff" to "ochraceous buff," at first with a raised, paler margin which later disappears; tissue of the basal stroma compact, pseudoparenchymatous, composed of hyaline to yellowish, thick walled, irregular cells about 5–15 μ in diameter, arranged in more or less vertically parallel rows above, in the central part the cells becoming more elongated and interwoven, toward the outside the cells in more or less oblique rows, smaller and thicker walled, and darker colored; subhymenium a narrow zone of slender, interwoven hyphae about 1.5–2.5 μ in diameter; asci cylindric-clavate, short stalked, eight spored, (80)–90–110–(120) $\times$ (12)–15–18–(21) μ; ascospores oblong-ellipsoid to ovoid, one to four celled, straight or slightly curved, hyaline becoming slightly yellowish, biseriate, (15)–18–25–(30) $\times$ (5)–7–9–(10) μ; paraphyses hyaline, filiform, septate, simple or branched, 1.5–2.0 μ in diameter, the tips swollen up to 5–7 μ and forming a slight epithecium.

Conidial fruiting bodies minute, inconspicuous, developing beneath the outer bark layers and raising and splitting them, forming small, blister-like elevations but not breaking through, circular to somewhat elongated, about 250–700 μ in diameter, consisting of a more or less conical or cushion-shaped basal stroma, sometimes almost flat, varying in thickness from 10 μ to 100 μ or more in the thicker, central part, pseudoparenchymatous at the base, composed of hyaline, irregular cells about 5–10 μ in diameter, becoming more prosenchymatous above in the thicker part, the cells becoming more elongated and more or less vertically parallel or somewhat interwoven; conidiophores arising from the surface of the stroma, hyaline, cylindric, continuous or septate, simple, occasionally branched, 7–25 $\times$ 3–5 μ; conidia oblong-ellipsoid, hyaline, one or two celled, straight or slightly curved, slightly narrowed toward the ends, one end with a truncate apiculus, (18)–21–25–

(30) × (6)–7–9–(10) μ; microconidia hyaline, filiform, straight or curved, one celled, 5–10 × 1.2–1.5 μ.

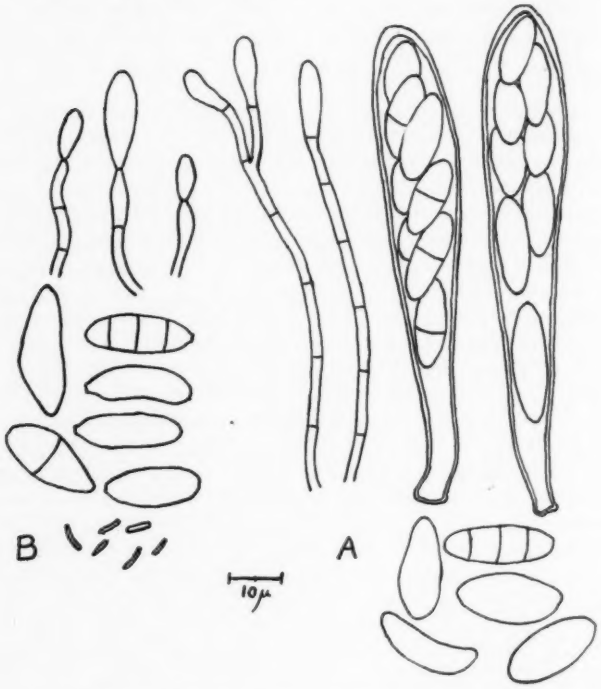


FIG. 1. *Pezicula carnea*. *A*, drawings of asci, ascospores, and paraphyses; *B*, conidiophores, conidia, and microconidia.

Host: *Acer* species, most commonly on *Acer rubrum* L.

EXSICCATI: Ellis, N. Am. Fungi *67a;* Fung. Columb. *246, 3420;* Rel. Farl. *112* (as *Dermatea acericola*); Rehm, Ascom. *1901* (as *Dermatea carnea f. seriata*); Sydow, Myc. March. *1579* (as *Dermatea quercina f. Aceris*).

SPECIMENS EXAMINED: Durand Herbarium. On *Acer rubrum. 3790,* Newfield, N. J. J. B. Ellis *2339.* Part of the type. *7335,* Newfield, N. J. Coll. J. B. Ellis. *7412,* Newfield, N. J. Coll. J. B. Ellis. This specimen is part of the type of *Dermatea simillima* Ellis & Ev.

Mycological Herbarium of the Division of Botany and Plant Pathology, Department of Agriculture, Ottawa. On *Acer rubrum. 5297 (592)*,[3] Duchesnay, Quebec—*5319 (589)*, McKeever, N. Y. Coll. L. O. Overholts *22130.*

University of Toronto Herbarium. On *Acer* sp. *2068,* Temagami Forest Reserve, Ont.

Herbarium of J. W. Groves. On *Acer rubrum. 459,* Mallory-ville Bog, near Ithaca, N. Y. W. L. White *1625—506,* Mt. Lake, Va. Comm. E. K. Cash—*560,* Bottomless Pit, N. H. L. O. Overholts *20566—591,* Duchesnay, Que.—*676,* Kingston, N. J. L. O. Overholts *7880—680,* Center Co., Penn. L. O. Overholts *4630—681,* Huntingdon Co., Penn. L. O. Overholts *21325—698,* Oconee Demonstration Forest, Ga. Comm. G. E. Thompson. On *Acer* sp. *462,* Huntingdon Co., Penn. W. L. White *2381—619, 699* (C. L. Shear *4172*), Duchesnay, Que.

On malt extract agar the colonies reach a diameter of 2–3.5 cm. in two weeks. They have a colorless, appressed margin and fairly abundant, fluffy-cottony, more or less tufted, aerial mycelium, white to buff or yellowish, often slightly greenish. The conidial fruiting bodies develop as rounded to irregular, fleshy stromata, about 1–3 mm. in diameter, covered with a sparse, downy, whitish to pale greenish-yellow mycelium, or almost glabrous and brownish, containing one or more irregularly lobed cavities which tear open irregularly and widely. The tissue is composed of closely interwoven, hyaline hyphae with the walls more or less grown together, looser at the outside and very compact around the cavities. The conidiophores and conidia are typical and microconidia are abundant.

On twigs of *Acer* a white to grayish-buff, fluffy-cottony, aerial mycelium develops around the point of inoculation and may spread rather sparsely over the twig. The conidial fruiting bodies are erumpent, rounded to almost globose, white to buff or yellowish, covered with a downy, aerial mycelium, firm, fleshy in consistency, 0.4–1.0 mm. in diameter and usually about 0.5 mm. in height, containing one or more rounded to more or less chambered cavities in the upper part. The basal stroma is thicker than in nature but

[3] The numbers in parentheses refer to duplicate specimens in the herbarium of J. W. Groves.

the tissue structure is similar. The conidiophores, conidia, and microconidia are typical.

Pezicula carnea was originally described by Cooke and Ellis (**1876**) as *Dermatea carnea* and was transferred to *Pezicula* by Rehm (**1912**), who listed *P. acericola* (Peck) Sacc. as a synonym. It was regarded as a synonym of *P. acericola* by Seaver and Velasquez (**1933**) and of *P. cinnamomea* (DC.) Sacc. by Wollenweber (**1939**).

The writer is convinced from an examination of type material of *P. acericola* and *P. carnea*, and from a comparison of cultures from ascospores and conidia of both fungi, that these should be regarded as two distinct species. *P. acericola* differs from *P. carnea* in its larger, more caespitose, more strongly erumpent, and brighter yellow apothecia, slightly broader asci, slightly larger ascospores, and definitely larger conidia. Cultures of *P. acericola* are white, occasionally buff to brownish, with abundant fluffy aerial mycelium, while cultures of *P. carnea* usually show greenish to yellowish tints and the aerial mycelium is less abundant and more tufted than in *P. acericola*.

It is evident from an examination of the available exsiccati cited by Seaver and Velasquez (**1933**) and from their figures and the description of their cultures, that they did not have the true *P. acericola* but were dealing only with *P. carnea*.

They observed this *Pezicula* growing in close association with pycnidia of *Sphaeronema acerinum* Peck and apothecia of *Dermatea acerina* (Peck) Rehm, and inferred that all three were stages of the same organism. The writer has observed this association in several collections and in the Duchesnay material it was very striking. However, cultures from ascospores of the *Dermatea* and conidia of the *Sphaeronema* proved to be identical with each other and different from cultures from ascospores of *P. carnea*, and when twigs bearing apothecia of *P. carnea* were placed in a moist chamber, spore masses of an inconspicuous *Cryptosporiopsis* appeared. Cultures from these conidia were identical with cultures from ascospores of *P. carnea*. These conidia are narrower and more pointed at the ends than conidia of *Sphaeronema acerinum* and, of course, are borne in an entirely different type of fruiting body. The association between apothecia of *P. carnea* and

pycnidia of *Sphaeronema acerinum* is, therefore, only one of chance and the true conidial stage of *P. carnea* is the *Cryptosporiopsis*.

Von Höhnel (**1916**) evidently observed this association also when he suggested that *S. acerinum* was the conidial stage of *Dermatea simillima* Ellis & Ev. Examination of part of the type of *D. simillima* in the Durand Herbarium disclosed that it was identical with *P. carnea*.

The taxonomy of *Pezicula cinnamomea* is in a state of confusion. Persoon (**1801**) described a *Peziza diluta β cinnamomea* but the description was too incomplete for the fungus to be recognizable and no host was mentioned. DeCandolle (**1815**) described a fungus occurring on oak as *Peziza cinnamomea* and this description might well apply to a *Pezicula*. Persoon (**1822**) again described a *Peziza cinnamomea*, this time giving the host as oak and citing DeCandolle's description, thus indicating that he considered his fungus to be the same species. Since, according to the International Rules, the priority of specific names dates from Fries' Systema Mycologicum, it should be noted that here *Peziza cinnamomea* was described as occurring on oak and the descriptions of DeCandolle and Persoon (**1822**) were cited. The combination *Pezicula cinnamomea* was published by Saccardo (**1881**).

Berkeley (**1881**) reported a fungus on maple as *Dermatea cinnamomea* (DC.). He evidently considered that he had DeCandolle's fungus, and there would seem to be no justification for the later appearance in the literature of the combination *Dermatea cinnamomea* Berk. & Br. for a fungus on maple.

Dermatea cinnamomea Cooke & Peck on *Populus* is a synonym of *Ocellaria ocellata* (Pers.) Schroet.

Tulasne (**1865**) described a *Pezicula* occurring on oak as *Pezicula amoena*. He observed a conidial stage associated with the apothecia and it is noteworthy that he described the conidia as narrower or about the same width as the ascospores. Fuckel (**1869**) also described a *Pezicula* on oak as *P. quercina*. Later (**1874**) he reported a fungus on *Alnus* without describing it, as *P. quercina* var. *Alni*, and a specimen on *Acer pseudoplatanus* was distributed in Syd. Myc. March. *1579* under the name *P. quercina* f. *Aceris* Rehm. Rehm (**1889**) described the *Alnus* fungus as a

distinct species, *P. Alni*, but retained the *Acer* fungus as a form of *P. Alni*. Later (**1896**) he listed it as a synonym of *P. acericola*, a treatment followed by the writer (**1938**). However, examination of the specimen in Syd. Myc. March. *1579* has subsequently shown that it is *P. carnea* and not *P. acericola*.

Wollenweber (**1939**) has brought together as synonyms under the name *P. cinnamomea*, such diverse forms as *P. Alni* Rehm, *P. aurantiaca* Rehm, *P. acericola* (Peck) Sacc., *P. carnea* (Cooke & Ellis) Rehm, *Dermatea acerina* (Peck) Rehm, and others. He did not study all these forms in culture, nor did he examine the types.

P. Alni and *P. aurantiaca* were recently described in detail by the writer (**1940**). It was shown that they are clearly distinct specifically and if the genus *Ocellaria* is recognised, *P. aurantiaca* could with equal justice be placed here and separated generically. Similarly with the species occurring on *Acer*, *Dermatea acerina* must be regarded as not only specifically, but generically distinct from *P. acericola* and *P. carnea*. The latter two can readily be separated from each other, and obviously all of these forms cannot be identical with *P. cinnamomea*.

It has not been possible to examine the types of the *Pezicula* species described on oak, and the taxonomy of these species is still not clear, but it seems certain that *P. cinnamomea* is a valid name for one of them. A culture, isolated by Jørgensen and labelled *P. cinnamomea*, was obtained from the Centraalbureau voor Schimmelcultures at Baarn. It produced both perfect and imperfect stages when grown on twigs of *Quercus* in flask cultures. Wollenweber (**1939**, p. *542*) evidently studied this same culture and considered it to be *P. cinnamomea*. However, it is very different in cultural characters and in size of conidia from *P. carnea*. The conidia are, in fact, wider than the ascospores, which would even seem to preclude the possibility of its being identical with *P. amoena* Tul.

A *Pezicula* has been collected on oak in the Temagami Forest Reserve, Ontario, and at the Petawawa Forest Experiment Station, Ontario, and this species also differs from the Baarn culture in cultural characters and in size of conidia. It also appears to be different from *P. carnea*, and may be *P. amoena* Tul.

All of the species listed as synonyms of *P. cinnamomea* by Wollenweber which the writer has studied in culture, *i.e., P. Alni, P. aurantiaca, P. acericola, P. carnea,* and *Dermatea acerina* have proved to be clearly distinct from Wollenweber's concept of *P. cinnamomea* as represented by the Jørgensen culture from Baarn, and also from the *Pezicula* collected on oak in Ontario. It would seem, therefore, that much more convincing proof than Wollenweber has offered should be forthcoming before his list of synonyms be accepted.

Pezicula subcarnea sp. nov.

Apotheciis erumpentibus, gregariis vel dispersis, plus minus seriatim instructis, solitariis vel caespitosis, orbicularibus, sessilibus, versus basim attenuatis, 0.4–0.8 mm. latis, 0.2–0.5 mm. altis, mollibus, ceraceis, in humido carnosis; hymenio plano vel convexo, leviter pruinoso, ochraceo, margine primum elevato, pallide, dein evanescente; hypothecio pseudoparenchymato; ascis clavatis, latis, breve stipitatis, octosporis, (90)–100–130–(150) × (21)–23–28–(30) μ; ascosporis elliptico-oblongis vel ovoideis, hyalinis vel luteolis, rectis vel leviter curvatis, continuis vel triseptatis, irrgulariter biseriatis, (21)–25–35–(40) × (10)–12–14–(16) μ; paraphysibus hyalinis, filiformibus, septatis, simplicibus vel ramosis, 1.5–2.0 μ diam., apice ad 5 μ incrassato, leve epithecium formantibus.

Hab. *Acer pennsylvanicum* L.

Apothecia erumpent, gregarious to scattered or more or less in rows, separate or in small clusters of two to six, circular, sessile, narrowed below, 0.4–0.8 mm. in diameter, 0.2–0.5 mm. in height, soft, brittle, waxy in consistency, becoming more fleshy when moist; hymenium plane to convex, slightly pruinose, close to "tawny" or "ochraceous" in color, brighter when moist, "zinc orange" to "ochraceous orange," the margin paler, at first slightly raised, then disappearing; tissue of the basal stroma compact, pseudoparenchymatous, composed of hyaline to pale yellowish, fairly thick walled, almost isodiametric cells 8–12 μ in diameter, arranged in more or less vertically parallel rows, curving obliquely toward the outside where the cells are darker and thicker walled; subhymenium a narrow zone of closely interwoven, indistinct hyphae; asci broadly clavate, short stalked, eight spored, (90)–100–130–(150) × (21)–23–28–(30) μ; ascospores oblong-ellipsoid to ovoid, hyaline to pale yellowish, straight or slightly curved, one to four celled, irregularly biseriate, (21)–25–35–(40) × (10)–12–14–(16) μ; paraphyses hyaline, filiform, septate, simple or branched, 1.5–2.0 μ in diameter, the tips swollen up to 5 μ and forming a slight, yellowish epithecium.

Conidial fruiting bodies minute, very inconspicuous, developing beneath the outer bark layers and raising and splitting them, forming small blister-like elevations, but not breaking through, circular

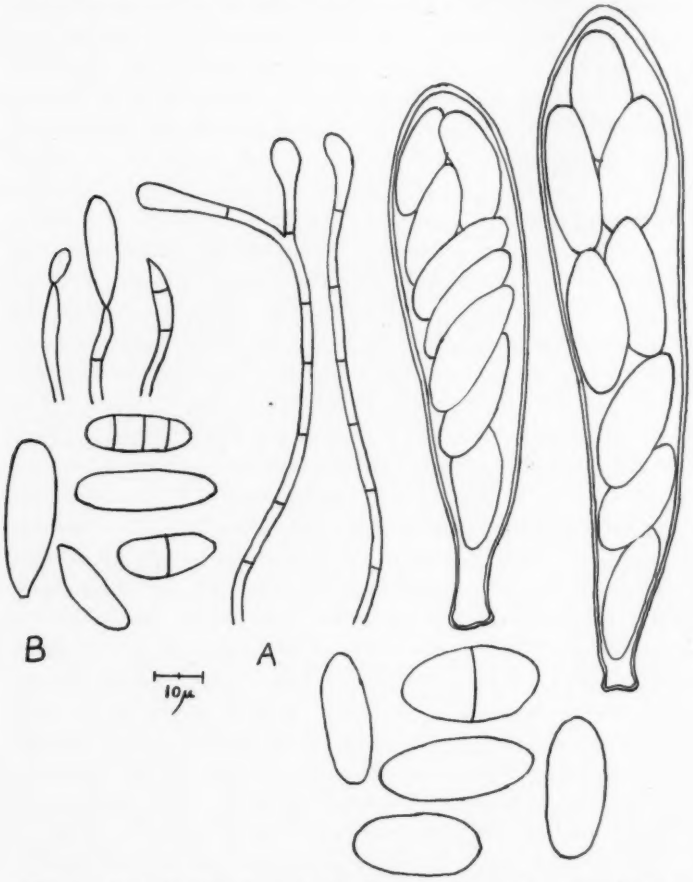


FIG. 2. *Pezicula subcarnea*. *A*, drawings of asci, ascospores, and paraphyses; *B*, conidiophores and conidia.

or slightly elongated, 250–450 μ in diameter, consisting of a pseudoparenchymatous basal stroma, composed of hyaline, irregular cells 4–7 μ in diameter, forming a layer 10–30 μ in thickness, sometimes thicker at the centre, conidiophores arising from the surface of this

layer, hyaline, cylindric, continuous or septate, simple, occasionally branched, pointed, 15–35 × 3–4 μ, sometimes swollen below the tip up to 5–6 μ; conidia oblong-ellipsoid, hyaline to slightly yellowish, straight or slightly curved, one to several celled, (20)–25–35–(40) × (7)–8–11–(14) μ; no microconidia have been observed.

Host: *Acer pennsylvanicum* L.

Type: Mycological Herbarium of the Division of Botany and Plant Pathology, Science Service, Ottawa, *2594,* Kingsmere, Que. Sept. 2, 1935.

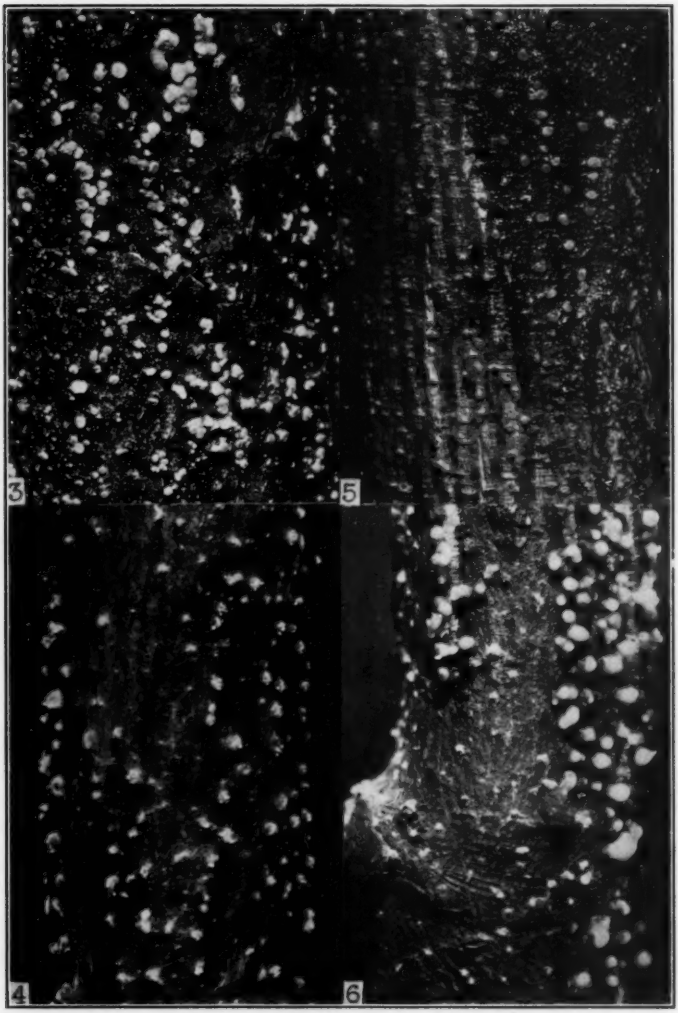
SPECIMENS EXAMINED: Mycological Herbarium of the Division of Botany and Plant Pathology, Ottawa. On *Acer pennsylvanicum. 2594 (439), 3992 (132),* Kingsmere, Que.—*5728 (662),* Temagami Forest Reserve, Ont.

University of Toronto Herbarium. On *Acer pennsylvanicum. 7269 (146), 7973 (326), 7975 (395),* Temagami Forest Reserve, Ont.

Herbarium of J. W. Groves. On *Acer pennsylvanicum. 429,* Temagami Forest Reserve, Ont.—*701,* Millinocket, Maine, Aug. 22, 1940, comm. E. K. Cash.

On malt extract agar the colonies grow slowly, reaching a diameter of about 3 cm. in three weeks. The margin is usually appressed and almost colorless. The aerial mycelium is grayish white to buff or brownish, cottony to somewhat collapsed, often not very abundant. The conidial fruiting bodies develop as a more or less rounded to irregular, fleshy stroma, about 1–3 mm. in diameter, covered with a downy, whitish mycelium, or almost glabrous and brownish, containing one or more irregularly lobed cavities which tear open very widely. The tissue is composed of hyaline to yellowish hyphae about 3–5 μ in diameter, fairly loosely interwoven at the base but forming a compact tissue above. The conidiophores and conidia are typical and no microconidia have been observed.

On twigs of *Acer,* little aerial mycelium is produced except for a tuft of whitish to brownish, more or less collapsed mycelium at the point of inoculation. The conidial fruiting bodies are sometimes immersed as in nature, sometimes more strongly erumpent, mostly about 0.2–0.4 mm. in diameter, sometimes up to 1 mm., sparsely covered with a thin, downy, aerial mycelium. The basal stroma is variable, sometimes very thin, about 10 μ in diameter,



FIGS. 3–6. 3, Apothecia of *Pezicula carnea;* 4, conidial stage of *P. carnea* on a twig of *Acer* in culture; 5, apothecia of *P. subcarnea;* 6, conidial stage of *P. subcarnea* on a twig of *Acer* in culture. All × 4 approx.

and composed of more or less longitudinally arranged hyphae from which the conidiophores arise, sometimes much thicker and pseudoparenchymatous, composed of thick walled, hyaline cells, 5–10 μ in diameter, forming a compact tissue around the cavity but looser toward the outside. The conidiophores and conidia are typical.

This species is distinguished from *P. carnea* chiefly by the size of the asci and ascospores. In *P. carnea* the asci are mostly 15–18 μ in diameter, rarely reaching 20 μ, while in *P. subcarnea* they are mostly 24–28 μ in diameter and only occasionally as narrow as 20 μ. They are much broader in proportion to their length in the latter, and so are a different shape. The ascospores of *P. carnea* are mostly 7–9 μ in diameter, while in *P. subcarnea* they are mostly 12–14 μ in diameter. The apothecia of *P. subcarnea* are usually a little smaller and have more orange in their colouration than those of *P. carnea*. Microconidia are abundant in cultures of *P. carnea* but have not been observed in cultures of *P. subcarnea*. *P. acericola* is intermediate with respect to ascus width but can be easily recognised by the larger, brighter yellow, more caespitose and more strongly erumpent apothecia.

It is, therefore, concluded that at least three species of *Pezicula* may be found on species of *Acer*. *P. acericola* occurs most commonly on *A. spicatum* and *P. carnea* most commonly on *A. rubrum*, while *P. subcarnea* has been collected only on *A. pennsylvanicum*. The conidial stage of each is a typical *Cryptosporiopsis*.

CENTRAL EXPERIMENTAL FARM,
OTTAWA, ONT.

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A NEW CERCOSPORA ON LEUCOTHÖE[1]

B. H. Davis[2]

(WITH 1 FIGURE)

The species of *Cercospora* described herein has been collected frequently on *Leucothöe Catesbaei* Gray in nurseries and ornamental plantings in New Jersey and has also been found on Long Island by H. H. Whetzel. An examination of either type or cotype specimens of Cercosporae described on Ericaceous plants shows this to be specifically distinct. The more important differences follow. The *Cercospora* on *Leucothöe* differs from *C. gay-lussaci* Speg. and *C. Kalmiae* Ellis & Ev. in its narrower conidia; from *C. Oxydendri* Tracy & Earle, *C. Kalmiae, C. sparsa* Cooke and *C. Gaultheriae* Ellis & Ev. in its subhyaline to pale olivaceous conidia; and from the last two and from *C. Handelii* Bubák in its conidia with long obconically truncate bases. Its very pale olivaceous conidiophores with almost hyaline tips distinguish it from *C. Epigaeae* Ellis & Dearness, *C. molleriana* Winter, and *C. Oxydendri.* Also its conidiophores are narrower than those of *C. Gaultheriae* and shorter than those of *C. molleriana.* The following name is proposed:

Cercospora Leucothoes sp. nov. (FIG. 1).

Maculae orbiculares vel interdum irregulares, aliquando restrictae foliorum venis, aliae definitores maculae cum angusta atra elevata margine, 4–12 mm. diametro, brunneae vel griseo-brunneae, vel sordide griseae in superiore superficie, minus definitae et paene ferrugineae in inferiore superficie; fungus amphigenus sed copiosior in superiore superficie; stromatis atris, globosis vel elongatis, 40–130 μ in longitudinem; fasciculis in superiore superficie con-

[1] Journal Series paper of the N. J. Agricultural Experiment Station, Rutgers University, department of plant pathology.

[2] The writer wishes to express his appreciation of the generous help of Dr. Charles Chupp in describing the species and in making available type specimens for examination.

fertis vel confertissimis, cum 2–12 conidiophoris in inferiore superficie; conidiophoris dilutissime olivaceis cum paene hyalinis apicibus, mediocriter uniformibus in latitudinem, longioribus conidiophoris flexuosis vel raro semel geniculatis, raro septatis, non-ramosis, cicatricibus sporarum non manifestis, apicibus rotundatis, 1.5–3 × 10–35 μ; condiis subhyalinis vel dilutissime olivaceis, cylindro-obclavatis (interdum distincte cylindricis vel conspicuiter obclavatis), ad bases longe obconico-truncatis, apicibus subacutis, directis vel curvatis, septis non-conspicuis, 1.5–3 × 20–90 μ, raro 120 μ, plerumque 40–75 μ.

Hab, in foliis et caulibus *Leucothöe Catesbaei* Gray, New Brunswick, N. J.

Leaf spots circular or sometimes irregular, occasionally bounded by leaf veins, some of the more definite ones with a narrow black

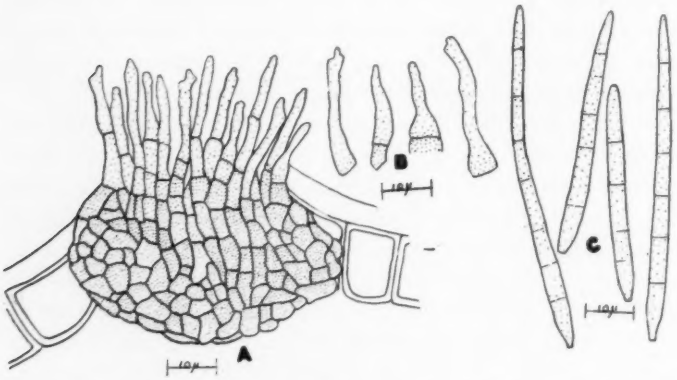

FIG. 1. *Cercospora Leucothoes*. *A*, stroma and conidiophores; *B*, conidiophores; *C*, conidia. Drawn with the aid of a camera lucida.

raised border, 4–12 mm. in diameter, brown to grayish brown or even dingy gray on upper surface, less definite and more nearly ferruginous on lower surface; fruiting structures amphigenous but more abundant on upper surface; stromata black, globular to elongate, 40–130 μ in length; fascicles on upper leaf surface dense to very dense, on lower leaf surface with 2–12 stalks; conidiophores very pale olivaceous with almost hyaline tips, fairly uniform in width, longer ones wavy or sparingly once abruptly geniculate, rarely with septa, unbranched, spore scars not evident, tips rounded, 1.5–3 × 10–35 μ; conidia subhyaline to very pale olivaceous, cylindro-obclavate (sometimes distinctly cylindric or plainly obclavate), base long obconically truncate, tips subacute, straight or curved, septa indistinct, 1.5–3 × 20–90 μ, rarely 120 μ, usually 40–75 μ.

On leaves and stems of *Leucothöe Catesbaei* Gray, New Brunswick, N. J.

Type material deposited in herbaria of Cornell University and New Jersey College of Agriculture.

N. J. AGRICULTURAL EXPERIMENT STATION,
NEW BRUNSWICK, N. J.

LIFE CYCLE OF PIGGOTIA FRAXINI, CAUSING LEAF DISEASE OF ASH

FREDERICK A. WOLF AND ROSS W. DAVIDSON [1]

(WITH 2 FIGURES)

A fungus commonly identified as *Piggotia Fraxini* Berk. & Curt. is among those most commonly and most widely found on the foliage of ashes throughout the United States. It appears appropriate herein to designate it *Piggotia* leaf disease of ash, since this stage of the causal fungus is most prominent and is best known to collectors. This disease is especially prevalent in nurseries and on small trees in the forest, but occurs also on large forest and shade trees. All of the more common species of ash are subject to attack, including white ash, *Fraxinus americana* L. (identical with *F. acuminata* Lam. and *F. lanceolata* Borkh. in some of the older collections); green ash, *F. pennsylvanica* Marsh. var. *lanceolata* (Borkh.) Sarg. (identical with *F. viridis* Michx.); Oregon ash, *F. oregona* Nutt.; and black ash, *F. nigra* Marsh. (identical with *F. sambucifolia* Lam.).

During the past few years our contacts with those interested in forest-tree nursery diseases and our examination of collections in herbaria show that this leaf disease occurs in Alabama, Georgia, Indiana, Illinois, Iowa, Kentucky, Louisiana, Massachusetts, Minnesota, Mississippi, Missouri, Nebraska, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Washington, Wisconsin, and Virginia. Furthermore, a consideration of pertinent mycological studies shows that the taxonomy of the pathogen is in a confused

[1] Grateful acknowledgment is made of the use of the following herbaria: Farlow Herbarium, Harvard University; Herbarium of the New York Botanical Garden; and Mycological Collections of the Bureau of Plant Industry, U. S. Department of Agriculture. We also wish to acknowledge the assistance of W. C. Davis, Dennis H. Latham, L. R. Roof, Ernest Wright, George Y. Young, Carl Hartley, and Bailey Sleeth in collecting specimens of ash diseases occurring in forest-tree nurseries.

state because it is polymorphic and no one has traced its developmental history. The present report, therefore, recounts our efforts to clarify these taxonomic matters as revealed by the sequential appearance of the several developmental stages of the *Piggotia* leaf disease fungus. The developmental cycle has been found to include a conidial stage, by means of which the pathogen is distributed during summer, a spermogonial and a carpogonial stage, the precursors of the perithecial stage, that appear coincidentally throughout the entire period from midsummer to early winter, and finally the perithecial stage, by means of which the organism hibernates. The perithecial stage matures in spring and is believed to constitute the primary inoculum for the conidial stage.

SOURCES OF MATERIAL

As has been indicated, trees of all ages are subject to this disease although it is especially severe upon young trees. An adequate description of its appearance, although highly desirable, has a limited usefulness, since it is unusual to find this leaf disease occurring alone. Instead, it is commonly associated with several other diseases whose causal agencies have not been given detailed study. Among the pathogens quite commonly found on leaves showing this *Piggotia* disease are the spermogonial stage, *Phyllosticta viridis* Ellis & Kellerm., of *Mycosphaerella fraxinicola* (Schw.) House, whose life history was recently studied (10); *Cylindrosporium Fraxini* (Ellis & Kellerm.) Ellis & Ev. (apparently synonymous with *Cercosporella Fraxini* Ellis & Kellerm., and with *Cercospora Fraxini* Ellis & Kellerm.); *Cylindrosporium viridis* Ellis & Ev.; *Septogloeum Fraxini* Hark. (apparently synonymous with *Gloeosporium Fraxini* (Hark.) Ellis & Ev.); and *Gloeosporium punctiforme* Ellis & Ev. Data showing the frequency of occurrence of some of these fungi in forest-tree nurseries are given in table 1.

The *Piggotia* stage was present on most of the leaves containing *Marssonia Fraxini* and on all of those containing *Gloeosporium punctiforme*, but in several instances the conidia of these two fungi were also present in the same collection of leaves, so it was not definitely determined whether *G. punctiforme* has a *Piggotia* stage

similar to *P. Fraxini*. Specimens of diseased leaves containing *Gloeosporium punctiforme* could, however, not be distinguished from those containing *Marssonia Fraxini* except by microscopic examination. This fact indicates that it too may be important as a cause of defoliation. *Cylindrosporium Fraxini*, *Cercospora* sp., and *Cylindrosporium viridis* each produce conspicuous, distinctive leaf spots.

This admixture of pathogens, oftentimes with three or four of them upon one and the same leaflet, has made it difficult to determine the symptom complex of each and to secure evidence of

TABLE 1

FUNGI ON ASH LEAVES COLLECTED IN NURSERIES, 1938 TO 1940

Fungus [1]	Number of specimens [2]	Distribution		Percentage of classified specimens
		Number of states	Number of localities	
Marssonia Fraxini	49	12	23	75.3
Cylindrosporium Fraxini	5	3	4	7.7
Cercospora sp.	5	3	4	7.7
Gloeosporium punctiforme	3	2	3	4.6
Cylindrosporium viridis	3	2	2	4.6
Totals	65			100.0

[1] Where several fungi were present in a collection they were recorded as separate specimens.

[2] A few specimens could not be identified because they lacked conidia.

genetic connections. These matters remained confused for several years but during the past year several clumps of small trees parasitized only by the organism under consideration were found. It has, therefore, been possible to make repeated observations throughout the year on these clumps of diseased trees, supplementing these observations by collections of specimens for immediate microscopic examination and for use in preparing paraffin sections.

APPEARANCE OF THE DISEASE AND STRUCTURE OF THE PATHOGEN

Conidial stage. Lesions bearing the conidial stage become evident about the middle of June, and conidia may continue to be formed until mid-September. Small yellowish-green indefinite spots on the upper leaf surface are the first evidence of disease.

Hundreds of flecks, none of which exceed 3 mm. in diameter, may occur on a single leaflet, in which case the entire leaflet is conspicuously yellow. Little discoloration is evident on the lower leaf surface but, with the aid of a hand lens, scattered, elevated structures are visible thereon. In moist weather these structures are pale flesh-colored, glistening, and protrude prominently, and in dry weather they are white and collapsed. By the use of paraffin sections they are seen to be acervuli, deeply seated in the spongy parenchyma (FIG. 1, *D*). The protrusions, that may extend 100 or more microns above the leaf surface, are composed of the conidial mass held together in a mucilaginous matrix. The acervular stroma may be so deeply embedded as to be hemispheric, and is composed of several layers of pale-brown, thin-walled cells (FIG. 1, *C*). The conidia are cylindrical, straight or slightly curved, obtuse-tipped, 1-septate, hyaline, and range in size from 17–40 (most commonly 24–28) $\times$ 3–4 μ (FIG. 1, *B*). These structural features are clearly those of the form genus *Marssonia*. In fact, when compared with exsiccati, the fungus is specifically identical with *Marssonia Fraxini* Ellis & Davis (**1**). This species was first collected in Vilas County, Wisconsin, by Dr. J. J. Davis, on the foliage of *Fraxinus nigra* (*F. sambucifolia*), and was described by him in 1903 and discussed in a later note (**2**).

Spermogonial and carpogonial stages. Within two or three weeks after conidia are first shed, numerous dark-brown to black structures have been formed interspersed among the acervuli. These structures soon become thickly dispersed over the entire lower leaf surface, and constitute the most conspicuous feature of the disease (FIG. 2, *A*). These structures continue to form and to mature not only while the leaves are still attached but long after the leaves have fallen. They have been collected over the entire period from early July to December.

Vertical sections of diseased leaves show that these dark structures are always deeply immersed within the leaf tissues, extending to the palisade parenchyma. Each structure is a stroma 100–200 μ in diameter, that contains one or more locules. These locules are of two types, spermagonial and carpogonial, both of which may be initiated within the same stroma and may develop coincidentally. The peripheral layer of the stromata is composed of thick-walled

cells, devoid of stainable content, and the medullary portion consists of loosely arranged, deeply staining, thin-walled cells. In the case of spermogonia, these medullary cells are the spermatium-mother cells, and in the carpogonia, the nurse tissue for the development of the asci.

Spermatial formation begins immediately beneath the ostiolar area and proceeds radially and basipetally. Details of the process are unknown except that the spermatia are abstricted as buds (FIG. 1, *E*) from the mother cells, after which the mother-cell walls disintegrate to form a mucilaginous matrix in which the spermatia are embedded. If moisture is present, the spermatia are exuded from the ostiolar orifice and adhere in a droplet or film. The spermatia are short-cylindric, hyaline cells 2–3 × 1 μ. Mature spermogonia seem multilocular, an appearance produced no doubt because the formation of spermatia does not proceed at the same rate, chains of spermatiferous cells remaining, as was described in the case of *Mycosphaerella fraxinicola* (**10**).

Comparison of this spermogonial stage with the type *Piggotia Fraxini* Berk. & Curt., collected in Pennsylvania by Michner, shows them to be identical. Specimens in herbaria show that various American mycologists have collected and identified this stage as *Piggotia Fraxini*. Collections sent to Europe have been given other names. Von Höhnel (**9**) called it *Dothichiza* (*Dothiopsis*), one of the Excipulaceae. Specimens on leaves of *Fraxinus oregona*, collected September 28, 1919, and sent to Sydow and Petrak (**8**), led them to conclude in 1922 that the organism might be made a new generic type. The following year Petrak (**7**) assigned it to *Asterostromella Fraxini* (Berk. & Curt.) Petrak, one of the Leptostromataceae. He pointed out, however, that it differed from *Asterostromella* only in the rather well developed, more or less dark-colored, pycnidial wall.

The carpogonial locules can be distinguished from spermogonia by the presence in each one of several deeply staining ascogonia that intertwine among the loosely arranged medullary cells (FIG. 1, *A*). Each ascogone is a septate filament whose trichogynal portion extends to the exterior. Presumably the spermatia lodge on these exposed trichogynes, through the agency of water, and the further

development of the carpogonia is contingent upon fertilization by the spermatia. Proof of fertilization is lacking, however.

Perithecial stage. Transformation of the carpogonial locules into perithecia takes place during winter while the decaying leaves are lying on the ground. As the fascicle of asci is forming, the deeply staining cells gradually disappear, indicating that they constitute the reserve food for the developing asci. In North Carolina some of the asci will have matured about the middle of March while the ascospores in others will not yet have been developed. Paraphyses are lacking. The asci adhere in fascicles as may be noted if perithecia are crushed in a drop of water under the cover glass. Mature asci are cylindrically saccate and measure 50–60 × 8–10 μ (FIG. 1, *F*). Each ascus contains eight biseriately arranged, hyaline, 2-celled ascospores. The upper cell is somewhat the larger.

COMPARISON WITH DESCRIBED SPECIES OF MYCOSPHAERELLA

These structural features show that the pathogen properly belongs in the genus *Mycosphaerella* (*Sphaerella*). In an effort to establish its specific identity, comparison was made first of all with the descriptions of species that have been recorded to occur on the foliage of ashes. The important comparative features of these species that should be considered are contained in table 2. From these descriptions it may be noted that the organism involved in our studies most nearly resembles *M. effigurata.*

In further efforts to identify this *Mycosphaerella* our collections have been compared with exsiccati. Such comparisons show that *S. maculiformis* and *S. punctiformis* are clearly distinct from our material. These two species occur on the foliage of various hardwoods, including *Quercus, Castanea, Acer, Platanus, Fagus, Hicoria, Tilia, Carpinus,* etc., both in Europe and in North America, for which reason they are undoubtedly different from the specialized pathogen involved in the present studies.

Sphaerella Fraxini (collected on *F. excelsior* L. in Hungary in 1883 by Linhart (presumably type specimens from Rehm's Ascomyceten No. *738*)) has much more densely aggregated perithecia and its ascospores are very much larger than those of our fungus. Furthermore, it is not known to occur on this continent.

In the type specimens of *Sphaerella fraxinea* the perithecia appear to be interspersed with those of *Mycosphaerella effigurata*. Some mycologists regard these species as identical. Ellis and Everhart (**6**, p. 268) state, "Specimens of *S. fraxinea* Pk. in our Herb. certainly agree well with Schweinitz' description of his *S. effigurata*." *S. fraxinea*, however, has ascospores that may readily be distinguished from *M. effigurata* since the lower cell of the former species is only one-fourth to one-third the size of the upper, while those of the latter are only slightly unequal. Collections of decaying ash leaves from the Duke Forest show ascospores like those described for *S. fraxinea*, and on these same leaflets perithecia were found that agree with those of *M. fraxinicola* and of *M. effigurata*. These three species appear to be confined to this continent.

TABLE 2

COMPARISON OF SPECIES OF *Mycosphaerella* OCCURRING ON LEAVES OF *Fraxinus* SPP.

Species	Distribution of perithecia	Dimensions of asci (μ)	Dimensions of ascospores (μ)
Mycosphaerella fraxinicola (Schw.) House	Hypophyllous, in spots	40–50×10–12	8–10×4–5
Mycosphaerella effigurata (Schw.) House	Hypophyllous, occupying entire leaf surface		15×4
Sphaerella fraxinea Peck	Amphigenous, in spots	30–40	10–12×4–5, upper cell 3–4 times the larger
Sphaerella maculiformis (Pers.) Awd.	Hypophyllous, in spots	50–60×7–8	14×3–4
Sphaerella punctiformis (Pers.) Rab.	Hypophyllous	28–45×7–9	6–9×2.5–3.0
Sphaerella Fraxini Niessl.	Hypophyllous, densely aggregated in groups	50–70×10–13	26–28×4
Sphaerella quadrangulata (Ellis & Ev.)	Epiphyllous, in white spots	60×12	16×4
Fungus under consideration	Hypophyllous, dispersed over entire lower leaf surface	50–60×8–10	15–18×4.5–6.0

Sphaerella quadrangulata, collected on *F. quadrangulata* Michx., is clearly distinct from the other species occurring on ash. This organism was first named *S. Sapindi* Ellis & Ev. because the host was erroneously identified as a species of *Sapindus*.

The organism under consideration is so widely prevalent in North Carolina in the area where Schweinitz collected for a period of years that it seems improbable that it could have escaped his notice. Schweinitz collected here both *M. fraxinicola* (*Sphaeria fraxinicola*) and *M. effigurata* (*S. effigurata*). These are distinct species although both may occur together on the same leaflet, as has been indicated. These facts incline us to the opinion that the organism under consideration is *M. effigurata*, although the admixture of perithecia of these two species and of those of *S. fraxinea* in exsiccati is a source of confusion which renders it impossible for anyone to be certain. Nevertheless it seems best to reëstablish the name *M. effigurata* rather than to create a new specific name.

Since this study for the first time clarifies the developmental cycle of the organism causing the *Piggotia Fraxini* leaf disease of ash, the name can best be reëstablished and taxonomic matters can be oriented by a brief descriptive summary as follows:

MYCOSPHAERELLA EFFIGURATA (Schw.) House, Emend, An index to the New York species of *Mycosphaerella*. N. Y. State Mus. Bull. 233–234, pp. 25–31. Albany, N. Y. 1921.

Syn: *Sphaeria effigurata* Schw., Syn. N. Am. Fungi No. *1790*.

Sphaerella effigurata (Schw.) Cooke, Jour. Bot. **21**: 107. 1883.

Piggotia Fraxini Berk. & Curt., N. Am. Fungi No. *433*.

Marssonia Fraxini Ellis & Davis, Trans. Wis. Acad. **14**: 97. 1903.

Septoria Besseyi Peck, Bull. Torrey Club **6**: 77. 1875.

Dothichiza ——— Höhnel, Sitz.-ber. Akad. Wien. **119**: 631. 1910. (Frag. Myk. No. *537*. 1910.)

Asterostromella Fraxini (Berk. & Curt.) Petrak, Ann. Myc. **23**: 268–269. 1923.

Peritheciis innumerosis, dispersis, saepe totum foliorum in pagina adversa occupantibus, discretis vel congestis, subinnatis, erumpentibus, nigris, sphaericis, 75–100 μ diam.; ascis fasciculatis, cylindricei-sacciformibus, aparaphysatis, 50–60 × 8–10 μ; sporidiis biserialis inordinatis, ellipticis, inaequaliter uniseptatis, loculo supero crassiore, vix constrictis, hyalinis, 15–18 × 4.5–6 μ.

Hab. in verno in pagina adversa foliorum dejectorum Fraxini spp., frequens.

Statum spermogonicum Piggotia fraxini B. et C. sistit. Spermogoniis et carpongoniis in aestivo atque autumno efformantibus, hypophyllis, innatis, in

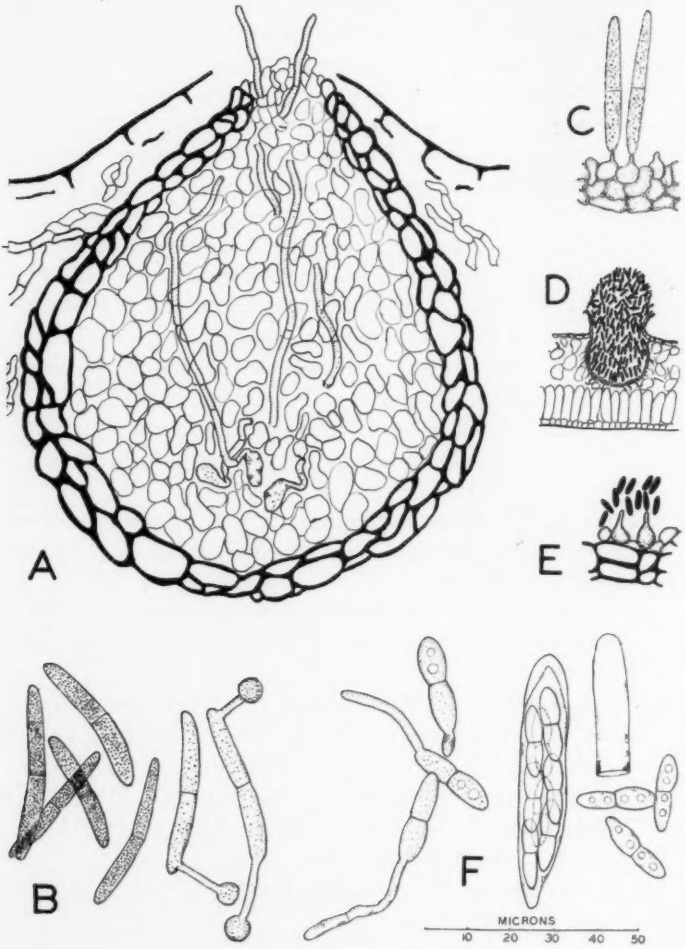

FIG. 1. All figures except *D* drawn to the same scale. *Mycosphaerella effigurata* (Schw.) House. *A*, median section of carpogonium with three ascogonial coils; *B*, conidia (*Marssonia Fraxini*), two germinated and showing appressoria; *C*, portion of acervulal wall with conidia; *D*, sketch of acervulus; *E*, spermatia and section of spermogonial wall; *F*, an ascus, germinating ascospores, ascospores, and thimble-like outer ascus membrane.

loculis stromaticis oriundis, solitariis vel congestis, punctiformibus, globosis, nigris, ca. 100 μ diam.; spermatiis bacillaribus, hyalinis, 2–3 × 1 μ.

Status conidicus: *Marssonia Fraxini* Ell. et Davis statum conidicum sistit. Maculis pallidis, minutis, indefinitis, innumerosis; acervulis innatis dein erumpentibus, in toto pagina inferiore foliorum sparsis; cirris pallide carneis; conidiis tereti-fusoideis, uniseptatis, rectisculis, hyalinis, 17–40 (saepius 24–28) × 3–4 μ.

Hab. in aestivo in foliis vivis Fraxini spp.

For the convenience of mycologists, specimens of the conidial, spermogonial and carpogonial, and ascigerous stages have been deposited in the Farlow Herbarium, Harvard University; in the herbarium of the New York Botanical Garden; and in the Mycological Collections of the Bureau of Plant Industry, U. S. Department of Agriculture.

COMPARISON OF PURE CULTURES

Comparative cultural studies were made not only of *M. effigurata* but of the associated species as follows:

(*a*) MYCOSPHAERELLA EFFIGURATA

F. P. *72189*. On *Fraxinus americana* from Washington, Ind., Sept. 1938, overwintered at Arlington, Va. Isolation from ascospores Mar. 10, 1939.

F. P. *72190*. On *Fraxinus americana* from Chapel Hill, N. C., Mar. 25, 1939. Isolation from ascospores Mar. 30, 1939.

F. P. *86489*. On *Fraxinus pennsylvanica* var. *lanceolata* from Mandan, N. Dak., Sept. 20, 1939, overwintered at Arlington, Va. Isolation from ascospores May 5, 1940.

F. P. *72181*. On *Fraxinus americana* from Charlottesville, Va., Sept. 7, 1938. Isolation from conidia Nov. 22, 1938.

F. P. *72182*. On *Fraxinus pennsylvanica* var. *lanceolata* from Clinton, Tenn., Sept. 28, 1938. Isolation from conidia Nov. 22, 1938.

F. P. *94039*. On *Fraxinus* sp. from Chapel Hill, N. C., July 19, 1940. Isolation from conidia Aug. 8, 1940.

(*b*) CYLINDROSPORIUM VIRIDIS

F. P. *72180*. On *Fraxinus pennsylvanica* var. *lanceolata* Clinton, Tenn., Sept. 27, 1938. Isolation from conidia Nov. 22, 1938.

(*c*) GLOEOSPORIUM PUNCTIFORME

F. P. *86486*. On *Fraxinus americana* from Stroudsburg, Pa., Sept. 4, 1939. Isolation from conidia Nov. 2, 1939.

(*d*) CYLINDROSPORIUM FRAXINI

F. P. *86487*. On *Fraxinus* sp. from Livingston, Ala., Oct. 23, 1939. Isolation from conidia Nov. 2, 1939.

Ascospores and conidia of *Mycosphaerella effigurata* germinate readily on cornmeal agar at ordinary room temperature of about 25° C. but subsequent growth is very slow.

Cultures from conidia were obtained by crushing spore horns in a drop of sterile water and placing this spore suspension on the surface of cornmeal agar. The use of a thin layer of agar facilitated observing germination and growth of the conidia when the dishes were inverted under a 4 mm. microscope lens.

Ascospore cultures were obtained by placing wet portions of overwintered leaves so that the ascospores could be expelled directly onto the surface of cornmeal agar. Germination and growth were then observed under the microscope in the same way as with conidia. Germinating ascospores were also studied under high magnification by removing the lids of the Petri dishes and focusing directly onto the surface of the agar. Unless germinating conidia and ascospores are allowed to develop undisturbed for a week or more before transfer to tubes of malt agar, they usually fail to grow.

The appearance and development of cultures from conidia and ascospores were similar in all respects. The mycelium developing from single spores becomes readily visible macroscopically only after a period of 10 to 18 days. The mycelium is hyaline at first, soon turning brown, and finally after 1 to 2 months on 2½ per cent malt agar is black. The lateral spread on cornmeal or malt agar is only 12 to 15 mm. during a 6 to 8 weeks' period, but the mycelium piles up on the surface of the agar in a thick, black, firm mass (FIG. 2, *B*). White to light brown gelatinous outgrowths or lobes of fungus tissue may develop from the margin of the culture, but these also gradually turn dark.

Pycnidia were never observed in cultures either from conidia or from ascospores. A few conidia were obtained from these cul-

tures, but they were usually abnormal in that one cell was globose or swollen. Conidia were never found in profusion in cultures as they are when developed under natural conditions.

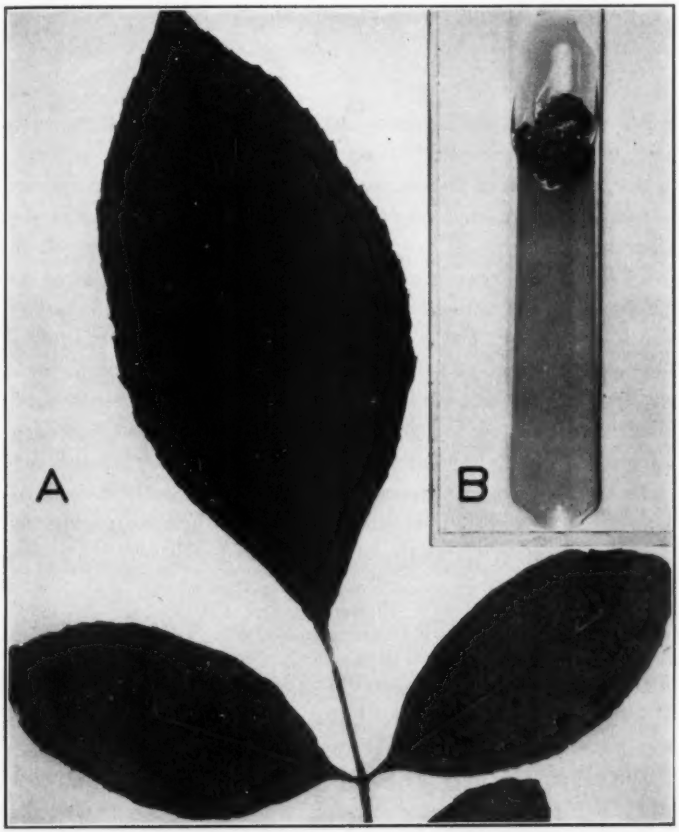

FIG. 2. *Mycosphaerella effigurata* (Schw.) House. *A*, photograph of underside of ash leaf showing the *Piggotia Fraxini* stage; *B*, culture of the fungus, two months old: grown on 2½ per cent malt agar.

The mycelial mass in cultures of *Cylindrosporium viridis* resembles somewhat that produced by *M. effigurata* but typical conidia were developed. Cultures of *Cylindrosporium Fraxini*

were distinctly different from those of *M. effigurata* but those of *Gloeosporium punctiforme* were very similar macroscopically. This latter species, however, forms 2-celled spores that are much shorter and thicker than the conidia of *M. effigurata,* and the spores are formed over the entire surface of the fungus mat.

PATHOGENICITY

All attempts in the laboratory and greenhouse to inoculate seedlings with cultures, conidia, and ascospores have failed to result in the production of the disease. It is probable that such factors as humidity, light, and temperature were not favorable. On the other hand, when old leaves bearing perithecia were attached to twigs of healthy trees in the forest, the conidial stage appeared on the young foliage after a minimal interval of 3 weeks. Infection also followed when leaves bearing conidia were attached to healthy twigs. In the case of trees with old diseased leaves beneath them on the ground, it was observed that there is a progressive upward involvement of the foliage, those nearest the ground becoming infected first in spring and then those more distant as summer advanced. These results leave little doubt of the pathogenicity of *M. effigurata,* and support the cultural studies that indicate the genetic connection of perithecial and conidial stages.

SUMMARY

The developmental cycle of a fungus commonly known as *Piggotia Fraxini* has been studied. The fungus attacks various species of ash throughout the United States and is especially common in forest-tree nurseries.

The pathogen is polymorphic, possessing a conidial stage, properly identified as *Marssonia Fraxini* Ellis & Davis, a spermogonial and carpogonial stage, commonly designated *Piggotia Fraxini* Berk. & Curt., and a perithecial stage, herein assigned to *Mycosphaerella effigurata* (Schw.) House. Evidence of a genetic connection of these stages is presented and an emended description of the fungus is included.

The pathogen is commonly associated in nature with such other species as *Mycosphaerella fraxinicola* (Schw.) House, *Sphaerella*

fraxinea Peck, *Cylindrosporium Fraxini* (Ellis & Kellerm.) Ellis & Ev., *Glocosporium punctiforme* Ellis & Ev., and *Cylindrosporium viridis* Ellis & Ev.

DEPARTMENT OF BOTANY,
DUKE UNIVERSITY,
DURHAM, NORTH CAROLINA,
AND
DIVISION OF FOREST PATHOLOGY,
BUREAU OF PLANT INDUSTRY,
U. S. DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.

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THE ASSOCIATION OF DIFFERENT ALTERATIONS IN SELF-FERTILE X-RAYED DERIVATIVES OF NEUROSPORA TETRASPERMA

WALTER SCOTT MALLOCH

While fungi were among the first organisms in which the retarding action of X-rays and radium were noticed (cf. Dauphin, **1904 a, b**; Ceresoli, (**1904**) **1907**; Dautwitz, **1906**), a detailed study of irradiation effects has been of more recent origin (cf. Nadson & Philippov, **1925**; Nadson & Rochlin, **1933**; Olenov, **1935**; Dodge & Seaver, **1938**). The stability of the induced alterations has been tested by means of subcultures (cf. Olenov, **1935**) and by progeny tests (cf. Dodge & Seaver, **1938**). A larger number of individuals may be tested by the first method, but the latter yields more precise information. Both of these methods have been used in this series of investigations, in addition to the statistical method of analysis to be presented in this paper.

Experiments in which ascospores of *Neurospora tetrasperma* were treated with Grenz rays and hard X-rays served to produce two populations which were suited for genetic studies. The first treatment consisted in irradiating ascospores with dosages of Grenz rays varying from 20,000 to 37,500 *r* units. These ascospores were soaked for twelve hours prior to activation for thirty minutes at a temperature of 61° C. The combination of prolonged soaking and short heat treatment promoted the maximum amount of growth in the resulting cultures. The second treatment consisted in irradiating ascospores with dosages of hard X-rays varying from 5,000 to 17,500 *r* units. These ascospores were then activated for ninety minutes at a temperature of 61° C., after having been in contact with a wet agar medium for two hours. This treatment tended to accentuate character expression and did not promote too rapid growth.

Previous reports on these experiments indicated that large numbers of variant cultures were induced by both methods of treatment

(cf. Goodspeed and Malloch, **1938, 1940**). These alterations were very similar in number and appearance to those produced when ascospores or conidiospores were subjected to high temperatures for different intervals of time. Among the progeny of the X-rayed ascospores, conidiospore production was either normal, defective, or absent. These same cultures were classified as to whether they had normal perithecia, many defective perithecia, few defective perithecia, or with perithecia absent. The self-fertile cultures were further subdivided according to whether ascospore production was good, medium, fair or poor. Finally, the color of substratum was listed as light, medium (normal), or dark. While the present paper will consider only the self-fertile cultures, the remaining forms will be described in a subsequent publication.

A preliminary observation of these cultures indicated that the alterations which were induced by high-frequency radiation tended to be associated. For instance, cultures with reduced sclerotia development were frequently observed to have a light color in the substratum, whereas cultures with normal perithecia development had a chestnut-brown color. One purpose of this investigation is to present the raw correlation data, including the frequency distributions, produced by the Grenz ray and hard X-ray treatment of ascospores. This is one of the few instances in which quantitative data are presented to show the relationship existing between alterations induced by X-radiation of fungi. Tests for the homogeneity of the data of the two populations have been made in regard to the frequency distributions and the correlation data. A difference in the severity of the treatments may affect the percentage of alterations observed without necessarily affecting the association existing between two characters. Tests have also been devised to determine which characters show an association after irradiation and which occur at random. In subsequent publications, data will be presented to test the stability and consequently the nature of these associations. In certain instances, the treatment may be so severe as to affect two characters simultaneously, one of which is conditioned by the cytoplasm, and the other by an alteration in the chromosomes. Such an association would tend to disappear in subsequent transfers due to recovery of the cytoplasm. An association which is due to a simultaneous change in two genetic factors,

however, should exhibit a certain measure of stability. The statistical treatment of the data involves the use of the chi-square test as described by Snedecor (**1938**). Having explained the experimental methods employed, the observed data may be presented.

EXPERIMENTAL RESULTS

All cultures represented in this test produced perithecia and ascospores, as may be inferred from the title. The detailed analysis is presented in Tables 1 to 6. The fact that two sets of data have been combined in the same table should cause no confusion, since the two populations are distinctly labeled. The results of the tests for homogeneity between the distribution of individual characters in the two populations may be listed as follows:

Character	Test	X^2	P
Ascospore production	1	39.9361	<.01
Color of substratum	1	14.7948	<.01
Conidiospore production	2	15.6750	<.01
Perithecia development	3	13.3919	<.01

Since the probability of occurrence is less than .01 in every case, we have reason to abandon the null hypothesis and look for some factor which may be causing a difference in the two populations. The most obvious factor would be a difference in the severity of the two treatments.

We may also test the homogeneity of the two populations in respect to the raw correlation data. The following values were obtained:

Characters	Test described in table	X^2	P
Ascospore production vs. color of substratum	1	58.2263	<.01
Ascospore production vs. conidiospore production	2	49.5841	<.01
Ascospore production vs. perithecia development	3	35.2311	<.01
Color of substratum vs. conidiospore production	4	25.8609	<.01
Color of substratum vs. perithecia development	5	28.6691	<.01
Conidiospore production vs. perithecia development	6	26.8479	<.01

TABLE 1

RAW CORRELATION DATA FOR COLOR OF SUBSTRATUM IN ORIGINAL TUBE AND ASCOSPORE PRODUCTION IN ORIGINAL TUBE OF SELF-FERTILE X-RAYED DERIVATIVES OF *Neurospora tetrasperma*

1	2	3	4	5	6	7
2			Color of substratum in original tube			
3	Ascospore production in original tube	Type of X-ray	Dark	Medium	Light	Totals for ascospore production
4	Good ascospore production	Hard	0	62	1	63
5		Grenz	0	124	0	124
6	Medium ascospore production	Hard	3	26	3	32
7		Grenz	32	61	2	95
8	Fair ascospore production	Hard	3	42	3	48
9		Grenz	16	29	4	49
10	Poor ascospore production	Hard	19	36	13	68
11		Grenz	22	14	6	42
12	Totals for color of substratum	Hard	25	166	20	211
13		Grenz	70	228	12	310

14	Test	Distribution	Rows combined	Columns combined	X^2	P
15	Homogeneity of hard X-ray and Grenz ray data	Color of substratum	4+6+8+10 5+7+9+11	None	14.7948	<.01
16		Ascospore production	None	4+5+6	39.9361	<.01
17		Correlation data	4+6, 8+10 5+7, 9+11	None	58.2263	<.01
18	Association of ascospore production and color of substratum	Hard X-ray	4+6, 8+10	None	20.3529	<.01
19		Grenz ray	5+7, 9+11	None	49.9502	<.01

Due to the fact that the probability values are less than .01 in every experiment, there is reason to suspect that the two populations are not homogeneous. It seems probable that the different X-ray and activation treatments have caused a variation in the distribution of the two populations. This difference consisted in the

TABLE 2

CORRELATION DATA FOR CONIDIOSPORE PRODUCTION AND ASCOSPORE PRODUCTION IN ORIGINAL TUBE OF SELF-FERTILE X-RAYED DERIVATIVES OF *Neurospora tetrasperma*

1	2	3	4	5	6	7
2			Conidiospore production in original tube			
3	Ascospore production in original tube	Type of X-ray	Normal	Defective	Absent	Totals for ascospore production
4	Good ascospore production	Hard	3	50	10	63
5		Grenz	29	78	17	124
6	Medium ascospore production	Hard	1	26	5	32
7		Grenz	16	56	23	95
8	Fair ascospore production	Hard	4	17	27	48
9		Grenz	4	32	13	49
10	Poor ascospore production	Hard	4	37	27	68
11		Grenz	2	19	21	42
12	Totals for conidiospore production	Hard	12	130	69	211
13		Grenz	51	185	74	310

14	Test	Distribution	Rows which were combined	Columns which were combined	X^2	P
15	Homogeneity of hard X-ray and Grenz ray data	Conidia	None	4+5	15.6750	<.01
16		Ascospore	None	4+5+6	39.9361	<.01
17		Correlation	4+6, 8+10, 5+7, 9+11	None	49.5841	<.01
18	Association of conidia and ascospore characters	Hard X-rays	4+6, 8+10	None	25.2602	<.01
19		Grenz rays	5+7, 9+11	None	17.7167	<.01

fact that the hard X-ray treatment caused a more sudden change, with a higher end point.

Since these tests indicate that the two populations are not homogeneous, it is a matter of interest to examine the association between characters in each population. For sake of emphasis, we

may repeat that in testing for association between characters, a null hypothesis is set up, but, in this case, the assumption is made that there is no association. The chi-square test of association between different characters may be listed in the following way:

Characters	Test described in table	Type of X-ray	X^2	P
Ascospore production vs. color of substratum	1	Hard	20.3529	<.01
		Grenz	49.9502	<.01
Ascospore production vs. conidiospore production	2	Hard	25.2602	<.01
		Grenz	17.7167	<.01
Ascospore production vs. parathecia development	3	Hard	111.4879	<.01
		Grenz	127.3401	<.01
Color of substratum vs. conidiospore production	4	Hard	10.8280	<.01
		Grenz	16.9173	<.01
Color of substratum vs. perithecia development	5	Hard	22.2020	<.01
		Grenz	74.3275	<.01
Conidiospore production vs. perithecia development	6	Hard	22.4909	<.01
		Grenz	18.5367	<.01

In considering these results, it may be noted that an association appears to exist between every pair of characters under consideration. This means that normal perithecia development is associated with normal conidiospore production, normal ascospore production, and normal color of substratum. Likewise, normal conidiospore production is associated with normal ascospore production and normal color of substratum.

Finally, it may be noted that the original data indicate that this association is by no means complete; for instance, cultures which failed to produce conidia may exhibit normal ascospore production, and cultures with a dark substratum may produce a normal amount of conidiospore growth.

Data presented in this article have demonstrated the manner in which X-rayed alterations are induced, but an important part of the investigation was to determine the hereditary nature of the new types. In order to obtain this information, a number of progenies were grown from spore prints. This procedure can be used to determine whether or not alterations are transmitted to the next generation, but it does not indicate the ratio in which they are inherited. The method is illustrated by the data presented in Table 7. Experiment G2414 represents cultures derived from original X-rayed ascospores of *N. tetrasperma*. Tube 37 (G2414

TABLE 3

RAW CORRELATION DATA FOR PERITHECIA DEVELOPMENT AND ASCOSPORE PRODUCTION IN ORIGINAL TUBES OF SELF-FERTILE X-RAYED DERIVATIVES OF *Neurospora tetrasperma*

1	2	3	4	5	6	7
2			Perithecia development in original tube			
3	Ascospore production in original tube	Type of X-ray	Normal perithecia	Many defective perithecia	Few defective perithecia	Totals for ascospore production
4	Good ascospore production	Hard	59	4	0	63
5		Grenz	124	0	0	124
6	Medium ascospore production	Hard	0	32	0	32
7		Grenz	0	95	0	95
8	Fair ascospore production	Hard	0	46	2	48
9		Grenz	0	40	9	49
10	Poor ascospore production	Hard	0	32	36	68
11		Grenz	0	23	19	42
12	Totals for perithecia development	Hard	59	114	38	211
13		Grenz	124	158	28	310

14	Test	Distribution	Rows combined	Columns combined	X^2	P
15	Homogeneity of hard X-ray and Grenz ray data	Production of perithecia	4+6+8+10 5+7+9+11	None	13.3919	<.01
16		Ascospore production	None	4+5+6	39.9361	<.01
17		Correlation data	4+6, 8+10 5+7, 9+11	None	35.2311	<.01
18	Association between ascospore production and development of perithecia	Hard	4+6, 8+10	None	111.4879	<.01
19		Grenz	5+7, 9+11	None	127.3401	<.01

T37) and Tube 39 (G2414 T39) of this population were characterized by defective conidiospore production, defective perithecia development, and medium ascospore production. F_2 progeny raised

from these cultures exhibited 100.0 and 94.4 per cent normal conidiospore production respectively. In these two populations, the total percentage of cultures with normal perithecia amounted to 97.9 and 95.5 per cent. Finally, the percentage of self-sterile cultures for the same progenies amounted to 1.1 and 4.4. Judging

TABLE 4

RAW CORRELATION DATA FOR COLOR OF SUBSTRATUM AND CONIDIOSPORE PRODUCTION IN ORIGINAL TUBES OF SELF-FERTILE X-RAYED DERIVATIVES OF *Neurospora tetrasperma*

1	2	3	4	5	6	7
2			Color of substratum in original tube			
3	Conidiospore production in original tube	Type of X-ray	Dark	Medium	Light	Totals for conidiospore production
4	Normal conidia	Hard	1	11	0	12
5		Grenz	4	46	1	51
6	Defective conidia	Hard	9	109	12	130
7		Grenz	44	138	3	185
8	Conidia absent	Hard	15	46	8	69
9		Grenz	22	44	8	74
10	Totals for color of substratum	Hard	25	166	20	211
11		Grenz	70	228	12	310

12	Test	Distribution	Rows combined	Columns combined	X^2	P
13	Homogeneity of hard X-ray and Grenz ray data	Color of substratum	4+6+8 5+7+9	None	14.7948	<.01
14		Conidiospore production	None	4+5+6	15.6750	<.01
15		Correlation data	6+8, 7+9	None	25.8609	<.01
16	Association between conidiospore production and color of substratum	Hard X-rays	6+8	None	10.8280	<.01
17		Grenz rays	7+9	None	16.9173	<.01

TABLE 5

RAW CORRELATION DATA FOR COLOR OF SUBSTRATUM AND PERITHECIA DEVELOPMENT IN ORIGINAL TUBES OF SELF-FERTILE X-RAYED DERIVATIVES OF *Neurospora tetrasperma*

1	2	3	4	5	6	7
2			Color of substratum in original tube			
3	Perithecia characters in original tube	Type of X-ray	Dark	Medium	Light	Totals for perithecia development
4	Normal perithecia	Hard	0	59	0	59
5		Grenz	0	124	0	124
6	Many defective perithecia	Hard	16	90	8	114
7		Grenz	66	87	5	158
8	Few defective perithecia	Hard	9	17	12	38
9		Grenz	4	17	7	28
10	Totals for color of substratum	Hard	25	166	20	211
11		Grenz	70	228	12	310

12	Test	Distribution	Rows combined	Columns combined	X^2	P
13	Homogeneity of hard X-ray and Grenz ray data	Color of substratum	4+6+8 5+7+9	None	14.7948	<.01
14		Perithecia production	None	4+5+6	13.3919	<.01
15		Correlation data	6+8, 7+9	None	28.6691	<.01
16	Association of perithecia production and color of substratum	Hard X-ray	6+8	None	22.2020	<.01
17		Grenz ray	7+9	None	74.3275	<.01

from this evidence, Tubes 37 and 39 may be considered as representing the so-called physiological type of alteration which is frequently induced by X-radiation. In other words, since recovery occurred in nearly all characters of the F_2 progeny, there was no basis for regarding such cultures as mutations.

In contrast to these results, we may consider the behavior of two additional populations. Tube 38(G2414 T38) of the original pop-

uation (G2414) was characterized by defective conidiospore production, normal perithecia development, and good ascospore production. Tube 41 (G2414 T41) showed the absence of conidiospore production, normal perithecia development, and medium ascospore production. In the F_2 progenies raised from these cultures, a certain measure of recovery occurred in conidiospore production and perithecia development, but the presence of a high percentage

TABLE 6

CORRELATION DATA FOR PERITHECIA DEVELOPMENT AND CONIDIOSPORE GROWTH IN ORIGINAL TUBES OF SELF-FERTILE X-RAYED DERIVATIVES OF *Neurospora tetrasperma*

1	2	3	4	5	6	7
2			Perithecia characters in original tube			
3	Conidia characters in original tube	Type of X-ray	Normal perithecia	Many defective perithecia	Few defective perithecia	Totals for conidia characters
4	Normal conidiospore growth	Hard	3	6	3	12
5		Grenz	29	21	1	51
6	Defective conidiospore growth	Hard	50	56	24	130
7		Grenz	78	94	13	185
8	Conidia absent	Hard	6	52	11	69
9		Grenz	17	43	14	74
10	Totals for perithecia characters	Hard	59	114	38	211
11		Grenz	124	158	28	310

12	Test	Distribution	Rows combined	Columns combined	X^2	P
13	Homogeneity of hard X-ray and Grenz ray data	Conidia	None	4+5+6	15.6750	<.01
14		Perithecia	4+6+8, 5+7+9	None	13.3919	<.01
15		Correlation data	4+6, 5+7	None	26.8479	<.01
16	Association of conidia and perithecia characters	Hard X-rays	4+6	None	22.4909	<.01
17		Grenz rays	5+7	None	18.5367	<.01

TABLE 7

PROGENY TESTS OF X-RAYED DERIVATIVES OF *Neurospora tetrasperma*

Number of culture	G2414	G2414 37F1	G2414 38F1	G2414 39F1	G2414 40F1	G2414 41F1	G2414 42F1
Percentage of cultures showing positive growth	89.0	95.0	76.0	90.0	24.0	40.0	83.0
Percentage of cultures with normal perithecia and normal conidia	33.7	97.9	73.7	92.2	0.0	50.0	55.4
Percentage of cultures with normal perithecia and reduced conidia	14.6	0.0	1.3	3.3	0.0	25.0	0.0
Total percentage of cultures with normal perithecia	48.3	97.9	75.0	95.5	0.0	75.0	55.4
Percentage of cultures with fertile defective perithecia	10.1	1.1	1.3	0.0	4.2	0.0	8.4
Percentage of cultures with sterile perithecia	20.2	0.0	1.3	3.3	16.7	0.0	0.0
Percentage of cultures with sclerotia	18.0	1.1	17.1	1.1	25.0	20.0	36.1
Percentage of cultures without sclerotia	3.4	0.0	5.3	0.0	54.2	5.0	0.0
Percentage of cultures without perithecia	21.4	1.1	22.4	1.1	79.2	25.0	36.1
Percentage of self-sterile cultures	41.6	1.1	23.7	4.4	95.9	25.0	36.1
Percentage of cultures without conidia	12.4	0.0	7.9	0.0	45.8	7.5	0.0
Percentage of cultures with defective conidia	44.9	0.0	10.5	5.6	33.3	30.0	0.0
Percentage of cultures with normal conidia	42.7	100.0	81.6	94.4	20.8	62.5	0.0
Percentage of cultures with defective forms	66.3	2.1	26.3	7.8	100.0	50.0	44.6

of self-sterile cultures was a significant indication of induced alterations.

The analysis may be continued by the study of another culture which is of particular interest in this regard. This culture (G2414 T40) was characterized by defective conidiospore production, defective perithecia development, and medium ascospore production. Tube 40 thus showed a strong resemblance to Tube 39, but the genetic behavior was quite different. The F_2 progeny raised from Tube 40 surpassed the original population (G2414) in the percentage of alterations produced. Normal conidiospore production was reduced to 20.8 per cent, and a high percentage of self-sterile cultures was found. Tube 40, then, represents an instance in which X-radiation induced a wide variety of heritable alterations.

Tube 42(G2414 T42) was distinguished by the absence of co-

nidiospore production, defective perithecia development, and medium ascospore production. In the F_2 progeny, the total percentage of cultures without perithecia amounted to 36.1 per cent, as compared with 21.4 per cent in the original population. In the hybrid population, the characters were so distinct that there could be no doubt as to the heritable nature of the alterations. A detailed ascus analysis of Tube 42 has been made, but it will be described in detail elsewhere.

DISCUSSION

Studies which have been made since the discovery of X-rays indicate that alterations in functional and structural characters can be induced by exposing fungi to high-frequency radiation (cf. Smith, **1936**). This investigation has extended these conclusions, in that many alterations in physiological and morphological characters were produced by subjecting ascospores of *Neurospora tetrasperma* to Grenz radiation and hard X-rays. In order to study the manner in which the alterations were induced, the activation treatment used in the Grenz-ray experiment was varied from the one used with hard X-rays, with the expectation that the alterations induced by the first treatment might show a different distribution from those produced by the second one. Conidiospore and ascospore production, perithecia development, and color of substratum were among the characters which were affected.

The statistical analysis presented in Tables 1 to 6 justified the experimental procedure adopted. A probability value of less than .01, which was obtained in every test, indicated that the frequency distributions of individual characters in the Grenz-ray and hard X-ray experiments were not homogeneous. A similar set of tests indicated that the correlation data for the two populations were not homogeneous either. In addition, the tests indicated that it would be advisable to calculate separate chi-square values in testing for the presence of an association between two characters.

Different methods of treatment were chosen in order to determine if two characters would still show an association in spite of a difference in the frequency distributions of the two populations. Probability values of less than .01 gave us reason to suspect that there was an association between the characters induced by the

original X-ray treatment. Having determined that X-ray-induced alterations tended to occur simultaneously, it was desirable to investigate the reason for this phenomenon.

The problem was approached by studying the genetic behavior of F_2 progenies. Data presented in Table 7 indicate that certain alterations were temporary in nature, while others had a genetic basis. It is to be noted that the characters of the original cultures were not transmitted as a unit but that segregation occurred. This is to be expected since the cultures were self-fertile X-rayed derivatives of *N. tetrasperma*. In order to produce a homozygous culture it would be necessary to affect both members of every allelomorphic pair under consideration. Evidence summarized by Schultz (**1936**) indicates that this is a very unlikely situation in higher organisms. It will be shown elsewhere that this condition has occurred in *N. tetrasperma,* but heterozygous cultures are more frequent.

The relationship existing between X-ray-induced alterations is a matter of considerable interest in that definite genetic factors are now known which affect these characters. Dodge and Seaver (**1938**) found that ascospore production was affected by two characters, *d* and *I*, for deliquescing and indurated ascus abortion. The present investigation has shown that a factor *p* has a marked influence on conidiospore and ascospore production, perithecia development, and color of substratum. Cultures having the genetic constitution *PP* were characterized by normal color and development, but cultures which were homozygous for the recessive factors *pp* showed pale, fluffy conidiospore growth and reduced perithecia development and ascospore production, as well as a light color in the substratum. In this case, the characters were associated because they were all conditioned by the same genetic factors.

Other factors were found which exhibit true genetic linkage. The factor *w* reduces hyphal growth and conidiospore production when in the haploid condition. The recessive factor *w* is strongly linked to the sex factor *A* which conditions pale conidiospore color. Regardless of the underlying cause, the characters which are associated are those which are present in the control and those which have been produced by X-radiation. However, the fact that it is possible to obtain every combination of two sets of characters,

such as conidiospore production and perithecia development, indicates that the X-rayed ascospores received different amounts of radiation and that different areas of the ascospores were affected. The interpretation of this data will be supported by additional evidence to be reported soon.

SUMMARY

1. In this experiment, cultures were raised from ascospores of *Neurospora tetrasperma* which had been exposed to Grenz radiation and hard X-rays.

2. The homogeneity of the frequency distributions was tested by the chi-square method. Frequency distributions for ascospore production, color of substratum, conidiospore production, and perithecia development in the Grenz radiation and hard X-ray experiments were not homogeneous.

3. In the two populations under consideration, correlation data for six different character contrasts were not homogeneous.

4. The chi-square tests indicate that good ascospore production was associated with normal perithecia development, normal color in substratum, and normal conidiospore production. Likewise, each of these characters was associated with all of the others.

5. Progeny tests demonstrated that certain induced alterations were unstable and returned to normal in the next generation, while others segregated into well-defined genetic types. In other words, the observed associations between different characters were sometimes due to genetic factors and sometimes to the fact that the treatment was sufficiently strong to affect two characters simultaneously.

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The investigations reported on here were aided by grants from the Radiation Committee of the National Research Council and the Committee on Research, University of California. Acknowledgment is also made of assistance under Works Progress Administration Project No. 65–1–08–91 Unit B–3. These investigations were carried out under the direction of Professor T. H. Goodspeed, to whom I am indebted for constant encouragement throughout the course of the work. I wish to express my gratitude to Professor

Lee Bonar for the privilege of frequent consultation in regard to these experiments. I am also indebted to my wife, Mrs. Frances W. Malloch, for valuable assistance in the preparation of this manuscript.

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INHERITANCE OF SORUS CHARACTERS IN HYBRIDS BETWEEN USTILAGO AVENAE AND U. PERENNANS[1]

GEORGE W. FISCHER AND C. S. HOLTON[2]

(WITH 3 FIGURES)

INTRODUCTION

Recently the writers (**4**) reported successful attempts at hybridization of *Ustilago Avenae* (Pers.) Jens. and *U. perennans* Rostrup, two morphologically indistinguishable species parasitizing cultivated oats (*Avena sativa* L.) and tall oatgrass (*Arrhenatherum elatius* (L.) Mert. & Koch.), respectively. Wild oats, *Avena fatua* L., was used as the host for the production of the F_1 chlamydospores. Seed of Anthony oats and tall oatgrass were inoculated with hybrid chlamydospores and segregates resembling the *U. Avenae* parent were obtained on the oats, but no infection was obtained on tall oatgrass and, consequently, neither the *U. perennans* parent nor a segregate resembling it was recovered on this host. Obviously, therefore, this failure to obtain infection of tall oatgrass with the hybrid chlamydospores constitutes a gap in the evidence that hybridization between these two species was demonstrated. It was observed, however, that certain segregates on Anthony oats were characteristically similar to those of *U. perennans* on tall oatgrass and this appeared to be further indication that hybridization had occurred. For this reason detailed studies were made to determine the nature of the segregates produced by the four hybrids on Anthony oats, especially with regard to sorus type.

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[1] Coöperative investigations of the Divisions of Forage Crops and Diseases and Cereal Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture, with the Washington State Agricultural Experiment Station, Pullman, Wash. Published with the approval of the director as Scientific Paper No. 485.

[2] Associate Pathologist, Division of Forage Crops and Diseases, and Associate Pathologist, Division of Cereal Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture.

U. perennans is characterized by the development, on tall oatgrass, of dark-brown, powdery sori which are covered by the partially-destroyed glumes. *U. Avenae* on oats, on the other hand, typically, produces dark-brown, powdery, naked sori. However, one of the two *U. Avenae* parents involved in the four hybrids discussed in this paper is characterized by indurate, black sori. Therefore, the hybrids of *U. perennans* with this black indurate race of *U. Avenae* involve the characters powdery sori, indurate sori, naked sori, and covered sori, as well as pathogenicity. This black indurate type of sorus in *U. Avenae,* and its heritability, have been fully described by Holton (**3**). At the same time preliminary cross-infection experiments with the two smut species were begun. The results of these studies are presented in this paper.

MATERIALS AND METHODS

Seed of Canadian oats (C. I. 1625) and four strains of tall oatgrass were inoculated with F_1 chlamydospores of four hybrids between *Ustilago Avenae* and *U. perennans,* inbred chlamydospores of the two parent races of *U. Avenae,* and mass chlamydospores of three field collections of *U. perennans.* The pedigree of the hybrid chlamydospores is shown in Table 1. In all four hybrids *U. perennans* is represented by the same pedigreed monosporidial lines, whereas *U. Avenae* is represented by four pedigreed monosporidial lines, two from each of the powdery and indurate sorus types recently described (**3**).

Inoculations also were made on Canadian, Victory (C. I. 560) and Anthony (C. I. 2143) oats with F_2 chlamydospores of 12 selections from the hybrids mentioned above, and with mass chlamydospores of the three collections of *Ustilago perennans.* The hybrid selections were based on type of sorus produced by the F_2 on Canadian oats and are designated as shown in Table 2.

The inoculum was prepared and the seed was treated and inoculated in the manner previously described (**3**). The tall oatgrass seed was planted in the greenhouse in $3 \times 3 \times 3''$ wooden veneer bands from which the seedlings were later transplanted to the field. The oats were planted and grown to maturity in the greenhouse. Under these conditions the host populations were too small for analysis on a ratio basis of the sorus types produced.

TABLE 1

RESULTS OF INOCULATIONS OF CANADIAN OATS AND TALL OATGRASS WITH F_1 SPORES OF FOUR *Ustilago Avenae* × *U. perennans* HYBRIDS, WITH *U. Avenae* SELFED, AND WITH THREE FIELD COLLECTIONS OF *U. perennans*

Species or cross	Sporidial combination	Type of inoculum	Per cent smut on				
			Canadian oats (C.I. 1625)	Tall oatgrass			
				W. 1719	W. 755	W. 447	W. 4295
U. Avenae 54 × *U. perennans* 8	1×3	F_1 spores	92.3	0.0	0.0	0.0	0.0
U. Avenae 54 × *U. perennans* 8	4×3	F_1 spores	21.8	0.0	0.0	0.0	0.0
U. Avenae 56 × *U. perennans* 8	1×3	F_1 spores	40.9	0.0	0.0	0.0	0.0
U. Avenae 56 × *U. perennans* 8	4×3	F_1 spores	56.0	0.0	0.0	0.0	0.0
U. Avenae 54 (selfed)	1×2	F_1 spores	92.9	0.0	0.0	0.0	0.0
U. Avenae 56 (selfed)	1×2	F_1 spores	82.6	0.0	0.0	0.0	0.0
U. perennans D-A1 (field col.)	—	Spores	12.2	22.2	26.4	23.0	15.6
U. perennans D-A2 (field col.)	—	Spores	5.2	19.2	40.0	25.0	25.0
U. perennans D-A3 (field col.)	—	Spores	8.4	23.8	31.8	66.6	12.5
Check rows	—	—	0.0	0.0	0.0	0.0	0.0

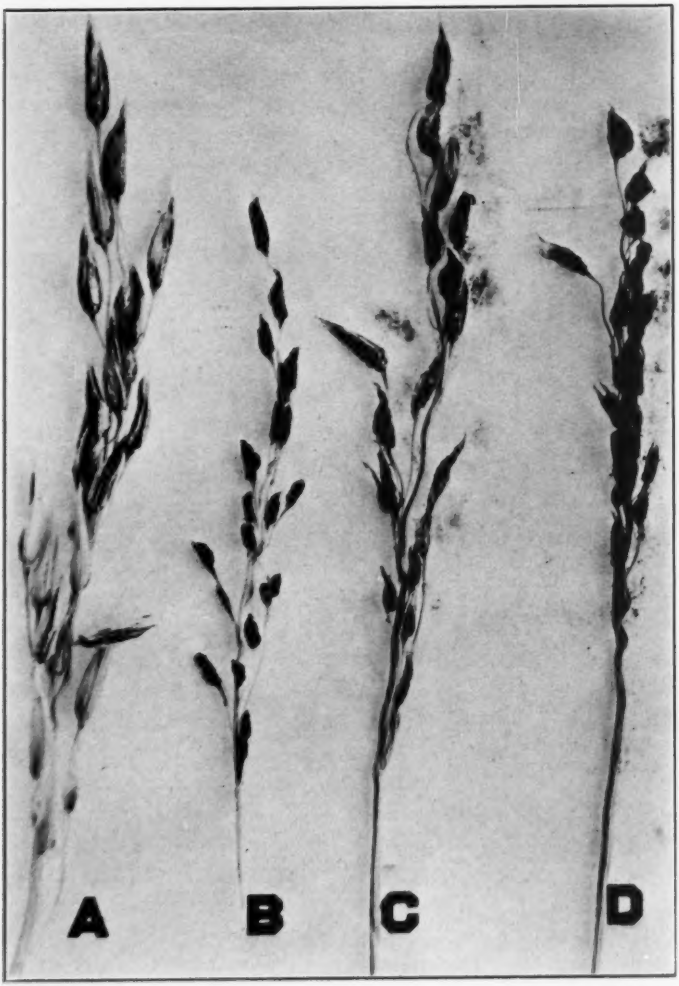

FIG. 1. Four types of F_2 segregates for sorus characters from a hybrid between *Ustilago Avenae* and *U. perennans*: *A*, covered indurate; *B*, naked indurate; *C*, covered powdery; *D*, naked powdery. On Anthony oats. Approx. nat. size.

TABLE 2

RESULTS OF INOCULATIONS OF THREE OAT VARIETIES[1] WITH *Ustilago perennans* AND WITH F_2 SEGREGATES OF FOUR HYBRIDS BETWEEN *Ustilago Avenae* AND *U. perennans*

Species or cross	Nature of inoculum			Per cent smut in F_3 on		
	Sporidial combination	Inoculum	Type of sorus in F_2	Canadian C.I. 1625	Victory C.I. 560	Anthony C.I. 2143
U. A. 56×U. p. 8	4×3[2]	F_2 spores	Covered	51.8	35.1	56.6
U. A. 56×U. p. 8	4×3	F_2 spores	Naked	28.5	9.3	27.5
U. A. 56×U. p. 8	1×3	F_2 spores	Covered	5.7	6.8	2.8
U. A. 56×U. p. 8	1×3	F_2 spores	Naked	7.6	2.7	9.0
U. A. 54×U. p. 8	1×3	F_2 spores	Powdery naked	42.3	6.8	44.1
U. A. 54×U. p. 8	1×3	F_2 spores	Indurate naked	26.6	10.0	19.3
U. A. 54×U. p. 8	1×3	F_2 spores	Powdery covered	80.0	70.5	76.4
U. A. 54×U. p. 8	1×3	F_2 spores	Indurate covered	83.3	53.5	95.4
U. A. 54×U. p. 8	4×3	F_2 spores	Powdery naked	50.0	12.1	23.5
U. A. 54×U. p. 8	4×3	F_2 spores	Indurate naked	66.6	22.2	29.7
U. A. 54×U. p. 8	4×3	F_2 spores	Powdery covered	76.9	68.4	78.2
U. A. 54×U. p. 8	4×3	F_2 spores	Indurate covered	94.2	64.2	95.4
U. perennans D-A1		Spores		40.0	28.5	58.3
U. perennans D-A2		Spores		85.7	20.0	78.5
U. perennans D-A3		Spores		12.5	37.5	33.3
Check rows				0.0	0.0	0.0

[1] No smut appeared on any of the four accessions of tall oatgrass from the hybrid inoculum.

[2] This represents the original interspecies sporidial combination that gave rise to the F_1 spores. Thus the parentage of U. A. 56 × U. p. 8, 4 × 3, is sporidium No. 4 (numbers begin at distal end of promycelium) of promycelium No. 56 of *U. Avenae* × sporidium No. 3 of promycelium No. 8 of *U. perennans*.

The separation or classification of sorus types was based on published descriptions (**3**) of the powdery and indurate types and their nature of inheritance, and on comparison with parent types produced on the same varieties under similar conditions.

RESULTS

F_1 and F_2 Generations

The percentages of infection produced by the F_1 generation of four hybrids between *Ustilago Avenae* and *U. perennans* were reported in a previous paper (**4**), but the type of smutted panicle produced was not described. In the more recent studies, however, this phase of the problem has been considered. In this connection it should be pointed out that the F_1 generation was produced on wild oats, while succeeding generations were on cultivated oats, and, consequently, the smutted panicles produced by the F_1 are not entirely comparable in character with those of the F_2 and F_3 generations. In other words, the loose smut type produced by *U. Avenae* on wild oats usually does not exhibit the naked sorus typical of this species on cultivated oats but often resembles to some extent the covered sorus type of *U. levis* (Kellerm. & Swingle) Magnus. Therefore, interpretation and classification of the type of smutted sorus produced by the F_1 on wild oats must be made in that light.

In all four hybrids the sori of the F_1 generation were classified as naked, indicating the dominance of this character of both *Ustilago Avenae* parents over the covered character of the *U. perennans* parent. In the two hybrids in which the *U. Avenae* parent was of the naked indurate sorus type, the results indicate that the powdery character of the *U. perennans* parent is dominant over the indurate character. In the other two hybrids, in which the *U. Avenae* parent was of the naked powdery sorus type, the results indicate that the naked character is dominant over the covered (*U. perenans*) character.

The results obtained from inoculations with F_1 chlamydospores are presented in Table 1. In keeping with the results previously reported (**4**) no infection was obtained on tall oatgrass inoculated with the four F_1 hybrids and the two selfs of *U. Avenae,* although

FIG. 2. *Ustilago perennans* on three varieties of cultivated oats: left to right, Anthony, Victory, and Canadian. Approx. nat. size.

the field collections of *U. perennans* produced from 12.5–66.6 per cent smut on this host. In contrast, Canadian oats was infected to the extent of from 21.8–92.3 per cent smut by the hybrid spores, 82.6 and 92.9 per cent by the two *U. Avenae* parents, and 5.2, 8.4, and 12.2 per cent by the three field collections of *U. perennans*. Apparently this is the first report of the infection of cultivated oats with *U. perennans*.

Among the smutted panicles produced by the F_2 generation of each hybrid involving the indurate race of *U. Avenae* (U. A. 54 × U. p. 8, 1 × 3,[3] and U. A. 54 × U. p. 8, 4 × 3) there were four types of segregates. These types, as shown in figure 1, represented different combinations of the four sorus characters involved (covered, naked, powdery, and indurate). In addition to the covered indurate and naked indurate segregates, the covered powdery and naked powdery parent types were produced in the F_2 on Canadian oats (fig. 1, *A*, *B*, *C*, and *D*, respectively). Apparently, therefore, the factors governing the four sorus characters involved in these hybrids are inherited independently. The two crosses in which the naked powdery *U. Avenae* parent was involved (U. A. 56 × U. p. 8, 1 × 3 and 4 × 3) segregated into covered powdery and naked powdery sori, the *U. perennans* and *U. Avenae* types, respectively.

F_3 Generation

The results of the inoculations with F_2 spores are presented in Table 2. Some infection was obtained from all of the inoculations on each of the three oat varieties, but again no infection of tall oatgrass by the hybrid chlamydospores was obtained. A high degree of susceptibility to the three collections of *Ustilago perennans* was exhibited by the three oat varieties. These collections of *U. perennans* were the same as those that produced the infection on tall oatgrass and Canadian oats shown in Table 1. Smutted panicles of the three oat varieties resulting from inoculation with *U. perennans* are shown in figure 2.

Segregation in the F_3 generation of the cross between the indurate sorus race of *Ustilago Avenae* with *U. perennans* (U. A.

[3] U. A. 54 and U. p. 8 designate the promycelia selected, of *Ustilago Avenae* and *U. perennans*, respectively, while 1 × 3 indicates the sporidial combination of the two species, respectively. (See footnote 1, Table 2.)

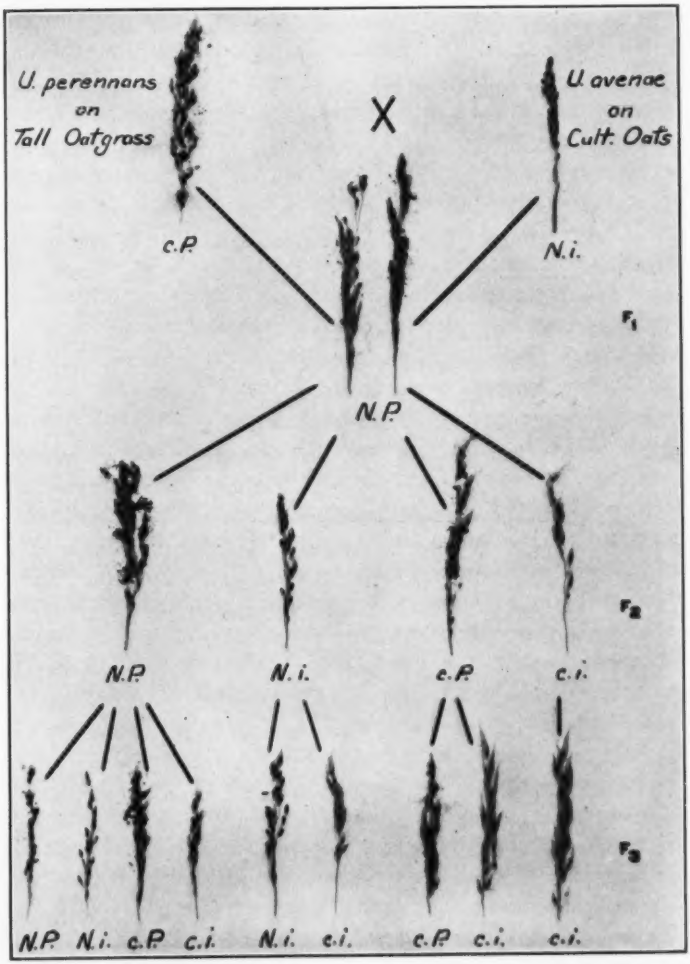

FIG. 3. Parental and F_1 sorus types and F_2, and F_3 segregates from a cross between *Ustilago Avenae* × *U. perennans*. F_1 on *Avena fatua*, F_2 and F_3 on *Avena sativa*. Legend: c.P. = covered powdery sori; N.i. = naked indurate sori; N.P. = naked powdery sori; c.i. = covered indurate sori. The dominance of powdery over indurate sori is indicated by upper case "P" for the former and lower case "i" for the latter. The dominance of naked over covered sori is indicated by upper case "N" for the former, and lower case "c" for the latter. Approx. ⅓ nat. size.

54 × U. p. 8, 1 × 3 and 4 × 3) further indicated that the powdery sorus character is dominant over the indurate character, as was found to be true in crosses between races of *U. Avenae* (3), and that the naked character of the *Avenae* parent is dominant over the covered character of the *perennans* parent. The sorus types produced by the parent species of this cross and the first three hybrid generations are shown in figure 3. As already pointed out, the F_1 sori on wild oats were powdery and in the F_2 generation on Canadian oats the sori were naked powdery, naked indurate, covered powdery, and covered indurate sori. The genetic nature of these segregates is indicated by the F_3 segregates shown in figure 3. The naked powdery type produced the four types observed in the F_2, thus indicating heterozygosity for all four characters. The naked indurate type segregated into naked indurate and covered indurate sori, indicating homozygosity for the indurate character and heterozygosity for the naked character. In contrast the covered powdery type segregated into covered powdery and covered indurate sori, indicating that it was homozygous for the covered character and heterozygous for powdery. The covered indurate type bred true, indicating that it was doubly homozygous. These results might have been expected on a theoretical basis, assuming complete dominance of the naked over the covered character, as was indicated in the F_1, and on the basis of heritability of the powdery and indurate characters (3).

As already stated, the two hybrids which involved the naked powdery race of *Ustilago Avenae* (U. A. 56 × U. p. 8, 1 × 3 and 4 × 3) segregated in the F_2 into the two parent types, indicating that the naked character is dominant over the covered. The naked F_2 segregates selected for inoculum produced naked and covered F_3 segregates, indicating that the former were heterozygous. The covered F_2 segregates produced only the covered type, indicating that they were homozygous.

DISCUSSION

The infection of cultivated oats with *Ustilago perennans* and the production of several hybrids between *U. perennans* and *U. Avenae* have a direct theoretical bearing on the possible relationship between the two species. McAlpine (7) and Cunningham (2) have

both held that the tall oatgrass smut does not merit specific distinction from *U. Avenae*. Inasmuch as the two species are indistinguishable on the basis of the morphology and germination of their spores this view seems logical, even if *U. perennans* were specialized to tall oatgrass and *U. Avenae* to *Avena* spp. Rösch (**8**) compared *U. perennans* and *U. Avenae* closely and concluded that they are very similar, both in saprophytic and parasitic existence, but that they are not identical in germination. Hüttig (**5**) found slight biophysical differences between the two species. These differences, however, are no more significant as species distinctions than similar or even greater differences which frequently exist between physiologic races of other species of parasitic fungi. The now established fact that *U. perennans* and *U. Avenae* can be hybridized, and that at least some oat varieties are decidedly susceptible to *U. perennans* would seem to be sufficient evidence that *U. Avenae* and *U. perennans* are one species.

A consideration of the complete synonomy furnished by Liro (**6**) indicates that originally the tall oatgrass smut and the loose smut of oats were considered as belonging to the old species *Uredo segetum* Persoon, and that Wallroth in 1815 recognized the tall oatgrass smut as *Uredo segetum decipiens*. The binomial at present most widely used for this smut is *Ustilago perennans*, the name proposed by Rostrup in 1890. Liro (**6**) maintained correctly that the oldest specific epithet should apply to the smut, and accordingly designated it as *Ustilago decipiens* (Wallroth) Liro. This name merits preference, to conform to International Rules of Botanical Nomenclature. The earliest specific designation given to the loose smut of oats was *Uredo segetum Avenae*, by Persoon in 1801 (1797 according to Clinton (**1**)). In 1889 Jensen assigned this smut to the genus *Ustilago* as *U. Avenae*, the name which is now universally recognized.

In consideration of the brief history of the synonomy of the two species of *Ustilago* in question, the name *U. Avenae* (Pers.) Jensen has priority over *U. decipiens* (Wallroth) Liro. Therefore, if consolidation of the two species is justifiable the former binomial should apply, and, on this basis, *U. perennans* would be recognized as a race of *U. Avenae*.

SUMMARY

Further evidence is presented that *Ustilago Avenae* and *U. perennans* will hybridize.

Crosses between *Ustilago Avenae* and *U. perennans* were made which involved four sorus characters, namely, covered, naked, powdery, and indurate.

The naked and powdery characters were found to be dominant over covered and indurate, respectively.

Independent inheritance of these characters is indicated by the fact that naked powdery, naked indurate, covered powdery, and covered indurate segregates were produced in the F_2 generation. These segregates broke up in the F_3 generation as follows: the naked powdery segregate gave rise to all four of the above-mentioned segregates; the naked indurate segregate produced naked indurate and covered indurate types; the covered powdery segregate produced covered powdery and covered indurate types; and the covered indurate segregate proved to be doubly homozygous in yielding only the covered indurate type of sorus. In crosses of *U. perennans* with a race of *U. Avenae* having normal powdery sori, only the covered vs. the naked sorus characters were studied. Again it was found that the naked sorus character is dominant over the covered sorus character.

The susceptibility of cultivated oats to *Ustilago perennans* was demonstrated, but tall oatgrass has not been found to be susceptible to *U. Avenae* nor to the hybrids between these two smuts.

That *Ustilago Avenae* and *U. perennans* are synonymous is indicated by the morphological identity of their chlamydospores, their genetic relationship, and host range.

A consolidated species would, by priority, be designated as *Ustilago Avenae* (Pers.) Jensen.

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NOTES AND BRIEF ARTICLES

RELATIVE DATES OF S. F. GRAY'S NATURAL ARRANGEMENT AND FRIES'S SYSTEMA

In the section of S. F. Gray's *Natural Arrangement of British Plants*[1] devoted to fungi was published a number of small and for the most part homogeneous genera of Hymenomycetes, since buried in the large and broadly defined groups of Fries, but often needed in the more precise mycological taxonomy of recent years. The use of these genera has frequently been limited by the doubt held by most mycologists whether the nomenclature of Gray's treatment, published in the same year as the first volume of the *Systema Mycologicum*, was available under the Rules—the uncertainty, that is, whether the *Natural Arrangement* was published after, or before, the *Systema*. In Seymour's host index[2] there is a footnote which reads: "In this work, S. F. Gray's Natural Arrangement of British Plants, 1821, is considered to be later than Fries, Systema Mycologicum, also 1821." The indication of this footnote has been followed by Miller,[3] in monographing the Hydnaceae, and by Cooke,[4] in discussing genera of the pore-fungi; but the evidence upon which Seymour's conclusion was based is not known, and none seems to have been presented elsewhere.[5] There is room for the suspicion that Gray's work has been neglected as being non-Friesian to the same extent to which it was earlier condemned[6] for being non-Linnaean.

Although the absolute dates of the two works cannot be accurately established by any evidence now at hand, their relative dates can be determined so as to leave no reasonable occasion for doubt. The engraved plates forming a part of the *Natural Arrangement*

[1] **1**: 507–676. 1821.
[2] Host index fungi N. Am. ix. 1929.
[3] Mycologia **25**: 286–302. 1933.
[4] Lloydia **3**: 81–104. 1940.
[5] Cf. Dodge, Mo. Bot. Gard. Ann. **21**: 709–710. 1934.
[6] Cf. Jour. Bot. **10**: 374–375. 1872.

are marked at the foot: "London, Published by Baldwin, Cradock & Joy, Paternoster Row, Nov^r. 1^st. 1821"; and there is no reason to suspect that they appeared before that date. For the first volume of the *Systema,* the only date given other than the year 1821 on the title-page is the one that appears at the end of the "Ratio Operis," on p. [viii]: "Dabam Lundae in Suecia d. 16 Nov. 1820." According to custom that date should mark the completion of the printing of the body of the work; but it still is not conclusive for the date of publication. However, in a "Historiola Studii mei Mycologici" which forms an introduction to Fries's *Monographia Hymenomycetum* [7] (and is quoted in the introduction to his *Icones* [8]), Fries wrote: "In the autumn of 1819 I brought back a greater abundance [of fungi] from the forests of Scania, with the result that many species then collected could be inserted in the first volume of the Systema Mycologicum, which went to press in that same year and was completed (absolutum est) in the following; however, the publisher caused the year on the title-page (in indice) of the book to read 1821." The time of appearance of the *Systema* was then, according to Fries, very late in 1820 (of necessity later than November 16th); it can scarcely have been after the very beginning of 1821. Unless proof to the contrary appears, the date for the purposes of the rules may well, on the grounds of Fries's statement, be considered to be January 1st, 1821.

Gray's *Natural Arrangement,* it follows, is post-Friesian, and the groups of Hymenomycetes published in it may be taken into account in tracing nomenclature or arriving at typification. It has recently been asserted [9] that the genus *Perispherostoma* Gray is "invalid because pre-*Systema.*" Whether any general statement concerning Gray's work is intended is not apparent. The genus in question is pyrenomycetous; it may be that no more was meant than that the nomenclature of the Pyrenomycetes commences with the second volume of the *Systema,* which presumably is later than the *Natural Arrangement.* Even if the latter be the intention, the nomenclature committee of the British Mycological Society has

[7] Monogr. Hym. Suec. viii. 1857.
[8] Icones Sel. Hym. **2**: ii. 1884.
[9] Trans. Brit. Myc. Soc. **24**: 283. 1940.

gone beyond the rules in the assertion quoted. The very useful and important motion placed before the last International Congress by Dodge (l. c.) to clarify mycological nomenclature by recognizing the year 1821, rather than the whole series of dates on which various parts of the *Systema* appeared, as a starting-point was left to a committee,[10] and ultimately to the next Congress, for action, and so there exists no authority for declaring a name invalid because pre-*Systema* unless it actually antedates the whole of the *Systema;* either interpretation of the starting-point rule (Art. 25, f) is at present permissible. The availability of Gray's nomenclature for some groups of fungi is therefore still open to doubt; for the Hymenomycetes, it is not only useful, but usable.—DONALD P. ROGERS.

MYCOLOGICAL SOCIETY OF AMERICA

REPORT ON THE 1939 FORAY

The 1939 Summer Foray of the Mycological Society of America was held in the Great Smoky Mountain National Forest where facilities for the studying and drying of specimens were provided at the Park Naturalists' Headquarters. To the Park Naturalists, and especially to Mr. Arthur K. Stupka, Park Naturalist, and Mr. Parker of the same service, the Society at its business meeting expressed its hearty thanks for their unfailing courtesy, cooperation and assistance, which made possible a most pleasant and profitable stay in an extremely beautiful region. The help of the Park Naturalists plus that of two members of our own society, Drs. L. R. Hesler and A. H. Smith, who had already done much collecting in the National Forest, enabled the members to proceed without undue delay to the most productive collecting grounds and as a result, in spite of the dry weeks that had preceded the foray, the members returned with ample collections for study during the evenings.

Those submitting reports (only eight out of thirty-three members) are listed below, preceded by a symbol which indicates the

[10] Zesde Int. Bot. Congr. Proc. 1: 341, 368. 1936.

name of the person who made the collections, or the institution in which they are preserved.

F = David H. Linder, Farlow Herbarium, Harvard University
H = Robert Hagelstein and Joseph H. Rispaud, New York Botanical Garden
M = Alexander H. Smith, University of Michigan
O = L. O. Overholts, Pennsylvania State College
S = Walter H. Snell, Brown University
W = Ross W. Davidson, C. L. Shear, John A. Stevenson, Bureau of Plant Industry, Washington, D. C.

MYXOMYCETES: *Arcyria cinerea* (Bull.) Pers. (H); *A. denudata* (L.) Wettst. (F, H); *A. incarnata* Pers. (H); *Ceratiomyxa fruticulosa* (Muell.) Macbr. (H); *Clastoderma Debaryanum* Blytt (H); *Comatricha pulchella* (Bab.) Rost. (H); *C. typhoides* (Bull.) Rost. (H); *Cribraria elegans* Berk. & Curt. (H); *C. intricata* Schrad. (H); *C. intricata* var. *dictyoides* (Cke. & Balf.) List. (H); *C. splendens* (Schrad.) Pers. (H); *C. tenella* Schrad. (H); *Diachea bulbillosa* (Berk. & Br.) List. (H); *D. leucopodia* (Bull.) Rost. (H); *Dictydiaethalium plumbeum* (Schum.) Rost. (H); *Dictydium cancellatum* (Batsch) Macbr. (H); *Diderma effusum* (Schw.) Morg. (H); *D. hemisphaericum* (Bull.) Hornem. (H); *D. rugosum* (Rex) Macbr. (H); *D. testaceum* (Schrad.) Pers. (H, W); *Didymium crustaceum* Fr. (H); *D. nigripes* (Lk.) Fr. (H); *D. squamulosum* (Alb. & Schw.) Fr. (H); *D. xanthopus* (Ditm.) Fr. (H); *Enerthenema papillatum* (Pers.) Rost. (H); *Fuligo septica* (L.) Weber (H); *F. septica* var. *rufa* Pers. (H); *Hemitrichia clavata* (Pers.) Rost. (H); *H. Serpula* (Scop.) Rost. (H); *H. Vesparium* (Batsch) Macbr. (H); *Lamproderma arcyrionema* Rost. (H); *L. columbinum* (Pers.) Rost. (H); *Leocarpus fragilis* (Dicks.) Rost. (H); *Lycogala epidendrum* (L.) Fr. (H); *Lycogala epidendrum* var. *exiguum* (Morg.) List. (H); *Oligonema flavidum* Peck (H); *Perichaena chrysosperma* (Currey) List. (H); *Physarum cinereum* (Batsch) Pers. (H); *P. citrinellum* Peck (H); *P. contextum* Pers. (H); *P. globuliferum* (Bull.) Pers. (H); *P. lateritium* (Berk. & Rav.) Morg. (H); *P. leucopus* Link (H); *P. Listeri* Macbr. (H); *P. melleum* (Berk. & Br.) Massee (H); *P. nucleatum* Rex (H); *P. nutans* Pers. (H); *P. penetrale* Rex (H); *P. psittacinum* Ditm. (H); *P. pulcherrimum* Berk. & Rav. (H); *P. sinuosum* (Bull.) Weinm. (H);

P. sulphureum Alb. & Schw. (H); *P. sulphureum* var. *sessile* G. List. (H); *P. superbum* Hagelstein (H); *P. tenerum* Rex (H); *P. viride* (Bull.) Pers. (H); *Prototrichia metallica* (Berk.) Macbr. (H); *Stemonitis axifera* (Bull.) Macbr. (H); *S. fusca* Roth (H); *S. pallida* Wing. (H); *S. splendens* Rost. (H); *Trichia Botrytis* (Gmel.) Pers. (H); *T. decipiens* (Pers.) Macbr. (H); *T. erecta* Rex (H); *T. favoginea* (Batsch) Pers. (H); *T. floriformis* (Schw.) G. List. (H); *T. persimilis* Karst. (H); *T. subfusca* Rex (H); *T. varia* Pers. (H).

PHYCOMYCETES: *Albugo Ipomoeae-panduranae* (Farl.) Swing. (W); *Plasmopara viticola* (Berk. & Curt.) Wilson (O); *Synchytrium decipiens* Farl. (F, O, W).

PLECTACALES: *Elaphomyces appalachiensis* Linder (F, M, W); *E. variegatus* Vitt. (F, W).

PYRENOMYCETES (sensu latu): *Adelopus balsamicola* (Pk.) Theiss. (W); *Anthostomella sepelibilis* (Berk. & Curt.) Sacc (W); *Balansia Hypoxylon* (Pk.) Atk. (W); *Botryosphaeria Ribis* (Tode ex Fr.) Grossenb. & Duggar (W); *Caliciopsis pinea* Pk. (W); *Camarops pugillus* (Schw.) Shear (W); *Chromocreopsis cubispora* (Ell. & Holw.) Seaver (W); *Clypeolella Leemingii* (Ell. & Ev.) Theiss. (W); *Cordyceps agariciformia* (Bolt.) Seaver (F); *C. intermedia* Imai (F, M, W); *C. militaris* (L.) Link (F, O); *C. michiganensis* Mains (W); *C. ophioglossoides* (Ehr. ex Fr.) Link (F, W); *C. parasitica* (Willd.) Seaver (O); *C. sphecophila* (Kl.) Mass. (F, O, W); *Creonectria cucurbitula* (Sacc.) Seaver (W); *Cryptodiaporthe aculeans* (Schw.) Wehm. (F, W); *Daldinia concentrica* (Bolt. ex Fr.) Ces. & deNot. (W); *Diatrypella discoidea* Cke. & Pk. var. *Alni* Cke. (W); *Dimerosporium Tsugae* Dearn. (W); *Dothichloe atramentosa* (Berk. & Curt.) Atk. (W); *Endothia parasitica* (Murr.) Anders. & Anders. (W); *Erysiphe Cichoracearum* DC. (W); *Fracchiaea heterogenea* Sacc. (W); *Glonium stellatum* Muhl. (W); *Gnomonia ulmea* (Sacc.) Thuem. (W); *Hypocrea gelatinosa* Tode ex Fr. (O); *H. patella* Cke. & Pk. (W); *H. rufa* Pers. ex Fr. (F); *H. rufula* Pers. ex Fr. (W); *Hypoderma brachysporum* (Rost.) Tub. (O); *H. commune* (Fr.) Duby (W); *Hypomyces aurantius* (Pers. ex Fr.) Tul. (W); *H. chrysospermus* Tul. (F, W); *H. lactifluorum* (Schw.) Tul. (O); *H. rosellus* (S. & S.) Tul. (F); *Hypoxylon*

commutatum Nke. (W); *H. fuscum* (Pers. ex Fr.) Fr. (W); *H. rubiginosum* (Pers. ex Fr.) Fr. (W); *Hysterium insidens* Schw. (W); *Hysterographium Mori* (Schw.) Rehm (W); *H. vulvatum* (Schw.) Sacc. (W); *Lasiosphaeria ovina* (Pers. ex Fr.) Ces. & deNot. (W); *Meliola bidentata* Cke. (W); *Microsphaera Alni* var. *Vaccinii* (Schw.) Salmon (O); *Myriangium Duriaei* Mont. & Berk. (F); *Nectria cinnabarina* Tode ex Fr. (W); *N. flavo-ciliata* Seaver (W); *N. ochroleuca* Schw. (W); *N. Peziza* Tode ex Fr. (W); *Nummularia tinctor* (Berk.) Ell. & Ev. (W); *Peckiella lateritia* (Fr.) Maire (W); *Phyllachora Lespedezae* (Schw.) Sacc. (F, W); *P. vulgata* Theiss. & Syd. (W); *Physalospora Rhododendri* (deNot.) Sacc. (W); *Rhytisma Vaccinii* (Schw.) Fr. (F, W); *Rosellinia Clavariae* (Tul.) Winter (O); *R. subiculata* (Schw.) Sacc. (W); *Scoleconectria balsamea* (Cke. & Pk.) Seaver (W); *Ustulina vulgaris* Tul. (W); *Xylaria Hypoxylon* (L.) Grev. (S); *X. polymorpha* (Pers.) Grev. (O).

DISCOMYCETES: *Aleuria cestrica* (Ell. & Ev.) Seaver (W); *Belonidium introspectum* (Cke.) Sacc. (W); *Calycina macrospora* (Pk.) Seaver (W); *Chlorosplenium aeruginascens* (Nyl.) Karst. (W); *C. chlora* (Schw.) Curt. (W); *C. versiforme* (Pers. ex Fr.) Karst. (W); *Coryne sarcoides* (Jacq. ex Fr.) Tul. (W); *Cyathicula petiolorum* (Rob. & Desm.) Sacc. (W); *Dasyscypha Agassizii* (Berk. & Curt.) Sacc. (W); *D. cerina* (Pers. ex Fr.) Fckl. (W); *D. nivea* (Fr.) Sacc. (W); *Dermatea balsamea* (Pk.) Seaver (W); *D. Cerasi* (Pers. ex Fr.) deNot. (W); *Geoglossum glabrum* (Pers.) Fr. (O); *Gloeoglossum difforme* (Fr.) Durand (F, O, S, W); *Helotium epiphyllum* (Pers.) Fr. (F, W); *H. phyllophilum* (Desm.) Karst. (O); *H. saprophyllum* Pk. (F); *H. scutula* (Pers. ex Fr.) Karst. (W); *Helvella atra* Oed. (O); *Ionomidotis fulvo-tingens* (Berk. & Curt.) Cash (W); *Lachnum sulfureum* (Pers. ex Fr.) Rehm (W); *Leotia lubrica* (Scop.) Fr. (O); *L. stipitata* (Bosc.) Schroet. (F, W); *Mollisia fumigata* (Ell. & Ev.) Sacc. (W); *M. melaleuca* (Fr.) Sacc. (W); *Patella albida* (Schaeff.) Seaver (W); *P. scutellata* (L.) Morg. (W); *Paxina fuscicarpa* Seaver (F); *P. hispida* (Schaeff.) Seaver (W); *Pezicula carnea* (Cke. & Ell.) Rehm (O); *P. Rubi* (Lib.) Niessl (W); *Peziza badia* Pers. ex Fr. (W); *P. violacea* Pers. (O); *Propolis faginea* (Schrad.) Karst. (W); *Rutstroemia macrospora*

(Pk.) Kanouse (F); *Sarcosoma carolinianum* Durand (W); *Schizoxylon insigne* (deNot.) Rehm (W); *Trichoglossum hirsutum* (Pers.) Boud. (O, W); *Tympanis conspersa* Fr. (W).

TUBERALES: *Hydnotria cubispora* (Bessey & Thompson) Gilkey (F); *Tuber separans* Gilkey (F).

UREDINALES: *Chrysomyxa roanensis* Arth. (W); *Coleosporium Elephantopodis* (Schw.) Thuem. (F, O, W); *C. Helianthi* (Schw.) Arth. (F); *C. inconspicuum* (Long) Hedgc. & Long (W); *C. Solidaginis* (Schw.) Thuem. (F, O, W); *C. Vernoniae* Berk. & Curt. (F, O, W); *Cronartium Quercuum* (Berk.) Miy. (W); *Gymnoconia Peckiana* (Howe) Trotter (F); *Kuehneola uredinis* (Lk.) Arth. (W); *Puccinia Circaeae* Pers. (O); *P. extensicola* var. *Solidaginis* (Schw.) Arth. (W); *P. marylandica* Lindr. (F, W); *P. tenuis* (Schw.) Barr. (O); *P. Verbesinae* Schw. (O, W); *Pucciniastrum Agrimoniae* (Schw.) Trans. (F, O, W); *P. Hydrangeae* (Berk. & Curt.) Arth. (F, O, W); *Uredinopsis macrosperma* (Cke.) Magn. (O); *U. mirabilis* (Pk.) Magn. (W); *Uromyces Hedysari-paniculati* (Schw.) Farl. (O); *U. Holwayi* Lagerh. (W); *U. Hyperici* (Spreng.) Curt. (F, O, W); *U. Lespedezae-procumbentis* (Schw.) Curt. (F, W).

PROTOBASIDIOMYCETES (except Uredinales): *Exidia glandulosa* (Bull.) Fr. (O); *Naematelea nucleata* (Schw.) Fr. (O); *Phleogena faginea* (Fr.) Lk. (F, W); *Platygloea Peniophorae* Bourd. & Galz. (F); *Sebacina incrustans* (Pers.) Tul. (O); *Septobasidium Curtisii* (Berk. & Desm.) Boed. & Steinm. (F); *Tremellodendron merismatoides* (Schw.) Burt (O, S); *T. pallidum* (Schw.) Burt (O, S); *Tremellodon gelatinosum* (Scop. ex Fr.) Pers. (O, S, W).

THELEPHORACEAE: *Aleurodiscus amorphus* Pers. ex Rabh. (W); *Asterostroma ochroleucum* Bres. (F); *Botryobasidium isabellinum* (Fr.) Rogers (F); *Ceratobasidium plumbeum* Martin (F); *Coniophora arida* (Fr.) Karst. (W); *Corticium investiens* (Schw.) Bres. (S); *C. octosporum* Schroet. (F); *C. radiosum* Fr. (O); *Corticium vagum* (Berk. & Curt.) Rogers (F); *Craterellus cantharellus* (Schw.) Fr. (O, S); *C. cornucopioides* (Schw.) Fr. (O); *C. odoratus* (Schw.) Fr. (O); *Cyphella cupulaeformis* Berk. & Rav. (W); *Hymenochaete corrugata* (Fr.) Lév. (F, W); *H. rubiginosa* (Dicks. ex Fr.) Lév. (W); *H. tabacina* (Sow. ex Fr.) Lév. (W); *Hypochnus* (= *Tomentella*) *fumosus* Fr. (O);

H. polyporoideus (Schw.) Overh. (W); *H. rubiginosus* Bres. (W); *Peniophora Pirina* Bourd. & Galz. (F); *Solenia? Brencklеanus* Sacc. (W); *S. anomala* (Pers.) Fckl. (W); *S. fasciculata* Pers. ex Fr. (W); *Stereum ambiguum* Pk. (W); *S. Burtianum* Pk. (O, S, W); *S. fasciatum* Schw. ex Fr. (O, W); *S. Chaillettii* Pers. (O); *S. lobatum* (Kze.) Fr. (F); *S. pallidum* (Pers.) Lloyd (F); *S. rameale* Schw. (O, W); *S. Ravenelii* Berk. & Curt. (F); *S. rugosum* Pers. ex Fr. (W); *S. sanguineolentum* (Alb. & Schw. ex Fr.) Fr. (W); *S. sulcatum* Burt (W); *Thelephora anthocephala* Bull. ex Fr. (W); *T. vialis* Schw. (O).

CLAVARIACEAE: *Clavaria botrytis* Pers. (F, O); *C. cristata* Holmsk. ex Fr. (F, O); *C. fennica* Karst. (O); *C. formosa* (Pers.) Fr. (F, O); *C. fusiformis* Sowerb. (F); *C. grandis* Pk. (O); *C. Kunzei* Fr. (F, O); *C. mucida* (Pers.) Fr. (O); *C. muscoides* L. (F); *C. obtusissima* Pk. (O); *C. pulchra* Pk. (O, W); *C. rufescens* (Schaeff.) Fr. (O); *C. subfalcata* Atk. (F); *Sparassis crispa* (Wulf.) Fr. (O).

HYDNACEAE: *Calodon amicum* Quel. (F); *C. scrobiculatum* (Fr.) Quel. (F); *C. zonatum* (Fr.) Quel. (F, O); *Hydnum alboniger* Pk. (O); *H. Ellisianum* (Bank.) Sacc. & Trott. (O); *H. fennicum* Karst. (O); *H. fuligineo-violaceum* Kalchbr. (O); *H. graveolens* (Delast.) Fr. (O); *H. imbricatum* (L.) Fr. (O); *H. ochraceum* Pers. ex Fr. (W); *H. repandum* L. (F, O); *H. rufescens* (Pers.) Fr. (O); *H. velutinum* Fr. (O); *Irpex cinnamomeus* Fr. (O, W); *I. farinaceus* Fr. (W); *Odontia arguta* (Fr.) Quel. (F).

POLYPORACEAE: *Daedalea confragosa* Bolt. ex Fr. (W); *Favolus Rhipidium* Berk. (O, S); *Fistulina hepatica* (Huds.) Fr. (O, S, W); *Fomes connatus* (Weinm.) Gill. (F); *F. igniarius* var. *laevigatus* (Fr.) Overh. (O); *F. lobatus* (Schw.) Cke. (O); *F. Pini* (Brot. ex Fr.) Karst. (W); *F. subroseus* (Weir) Overh. (O, W); *Lenzites betulina* (L.) Fr. (O, W); *L. saepiaria* Wulf. ex Fr. (W); *Merulius molluscus* Fr. (O); *Polyporus abietinus* Dicks. ex Fr. (O, W); *P. cinnamomeus* (Jacq.) Sacc. (F); *P. cristatus* (Pers.) Fr. (O); *P. elegans* Bull. ex Fr. (O, W); *P. fissilis* Berk. & Curt. (O); *P. hirsutus* Wulf. ex Fr. (W); *P. pargamenus* Fr. (F, W); *P. Pes-Caprae* (Pers.) Fr. (O); *P. pocula* (Schw.) Berk. & Curt. (W); *P. pubescens* Schum. ex Fr. (W); *P. radiatus* Sow. ex Fr. (O, S, W); *P. Schweinitzii* Fr. (S); *P. semipileatus*

Pk. (S); *P. semisupinus* Berk. & Curt. (W); *P. Spraguei* Berk. & Curt. (O, S, W); *P. sulphureus* Bull. ex Fr. (O); *P. versicolor* L. ex Fr. (F, O, W); *Poria spissa* Schw. (O); *P. subacida* Pk. (O).

BOLETACEAE: *Boletinus castanellus* Pk. (O, S); *B. pictus* Pk. (S); *B. squarrosoides* Snell & Dick (S); *Boletus affinis* Pk. (S); *B. alboater* Schw. (S); *B. auriflammeus* Berk. & Curt. (F, S); *B. auriporus* Pk. (S); *B. badius* Fr. (S, W); *B. bicolor* Pk. (O, S); *B. castaneus* Bull. ex Fr. (O, S); *B. chromapes* Frost (S); *B. chrysenteroides* Snell (O); *B. cyanescens* Bull. ex Fr. (F, S); *B. felleus* Bull. ex Fr. (S); *B. fumosipes* Pk. (S); *B. glutinosipes* Snell & Hesler (S); *B. gracilis* Pk. (O, S); *B. granulatus* L. ex Fr. (S); *B. longicurvipes* Snell & Smith (S); *B. ornatipes* Pk. (O, S); *B. pallidus* Frost (S); *B. parasiticus* Bull. ex Fr. (F, S); *B. Peckii* Frost (S); *B. piperatus* Bull. ex Fr. (O, S); *B. porphyrosporus* Fr. (S); *B. rubeus* Frost (S); *B. rubinellus* Pk. (O, S); *B. scaber* Bull. ex Fr. (O, S); *B. separans* Pk. (O); *B. subglabripes* Pk. (S); *B. subtomentosus* L. ex Fr. (S); *B. subvelutipes* Pk. (S); *Strobilomyces strobilaceus* (Scop. ex Fr.) Berk. (S).

AGARICACEAE: *Agaricus placomyces* Pk. (O); *A. sylvicolus* Vitt. (O); *Amanita bisporiger* Atk. (O); *A. chlorinosma* Pk. (O); *A. cinereoconia* Atk. (F); *A. spreta* Pk. (O); *Amanitopsis parcivolvata* Pk. (O); *A. vaginata* (Bull.) Roze (O); *Armillaria mellea* (Vahl) Fr. (O); *Cantharellus aurantiacus* Fr. (S); *C. cinnabarinus* Schw. (O, S); *C. floccosus* Schw. (O, S); *C. minor* Pk. (O); *Clitocybe cyathiformis* Bull. ex Fr. (O); *C. illudens* Schw. (F, O); *C. laccata* Scop. ex Fr. (O); *C. ochropurpurea* Berk. (O, S, W); *C. parilis* Fr. (O); *Clitopilus orcellus* Fr. (O); *Collybia abundans* Pk. (O); *C. colorea* Pk. (O); *C. conigenoides* Ellis (O); *C. conigena* Fr. sensu Bres. (F); *C. dryophila* Bull. ex Fr. (O); *C. exsculpata* (Fr.) Gillet (M); *C. flaccida* Smith & Hesler (M); *C. maculata* Alb. & Schw. (O); *C. platyphylla* Fr. (O); *C. radicata* (Relk.) Fr. (O); *Cortinarius cinnabarinus* Fr. (O); *C. croceofolius* Pk. (O); *C. flavifolius* Pk. (M, O); *C. ioides* Berk. & Curt. (S); *C. purpurascens* Fr. (F, M); *C. semisanguineus* (Fr.) Kauffm. (O); *Crepidotus applanatus* Fr. (O); *C. haerens* Pk. (O); *C. herbarum* Pk. (F, O); *Entoloma cuspi-*

datum Pk. (O); *E. cyaneum* Pk. (M); *Flammula polychroa* Berk. (O); *Hygrophorus conicus* Fr. (M, O); *H. marginatus* Pk. (O); *H. miniatus* Fr. (O); *H. Peckii* Atk. (O); *Hypholoma delineatum* Pk. (O); *H. fasciculare* (Huds.) Fr. (O); *Inocybe lilacina* (Boud.) Kauffm. (O); *Lactarius Allardii* Coker (O); *L. atroviridis* Pk. (O); *L. camphoratus* Bull. ex Fr. (O); *L. chrysopheus* Fr. (O); *L. cinereus* Pk. (O); *L. corrugis* Pk. (O); *L. croceus* Burl. (M, O); *L. deliciosus* (L.) Fr. (O); *L. fuliginosus* Fr. (F, O); *L. Gerardii* Pk. (O); *L. glaucescens* Crossl. (O); *L. griseus* Pk. (O); *L. hygrophoroides* Berk. & Curt. (O); *L. indigo* (Schw.) Fr. (M, O); *L. lignyotus* Fr. (O); *L. maculatus* Pk. (O); *L. piperatus* Fr. (O); *L. plinthogalus* (Otto) Burl. (O, S); *L. pyrogalus* Fr. (S); *L. rimocellus* Pk. (O); *L. rusticanus* (Scop.) Burl. (O); *L. subdulcis* (Pers.) Fr. (O); *L. subplinthogalus* Coker (O, S); *L. subpurpureus* Pk. (S); *L. theiogalus* Fr. (S); *L. trivialis* Fr. (O); *L. vellereus* Fr. (O); *L. volemus* Fr. (O, S); *Lepiota Grangei* (Eyre) Lange (M); *L. lutea* (Bolt.) Quel. (M, S); *Leptonia strictius* Pk. (O); *Marasmius albiceps* Pk. (O); *M. androsaceus* Fr. (O); *M. felix* Morgan (O); *M. magnisporus* Murr. (F, O, W); *M. resinosus* Pk. (O); *M. siccus* Schw. (O); *M. subnudus* (Ell.) Pk. (O); *Mycena carolinensis* Smith & Hesler (M); *M. clavicularis* Fr. (S); *M. galoppus* (Fr.) Quel. (M); *M. leaiana* Berk. (O); *M. odorifera* Pk. (O); *M. rubromarginata* Fr. (F, M, O); *Nolanea dysthales* (Pk.) Atk. (O); *Omphalia stromboides* (Berk. & Mont.) Sacc. (M); *Panus levis* Berk. & Curt. (O); *P. stipticus* Fr. (O, W); *Paxillus atrotomentosus* Fr. (O); *P. involutus* Fr. (F); *P. pannuoides* Fr. (O); *Pleurotus griseus* Pk. (O); *P. petaloides* Fr. (O); *Pluteolus calestus* Pk. (M); *P. coprophilus* Pk. (O); *Pluteus admirabilis* Pk. (O); *P. cervinus* (Schaeff.) Fr. (O); *P. nanus* Fr. (O); *Russula crustosa* Pk. (S); *R. pectinatoides* Pk. (O); *R. rubescens* Beards. (S); *Stropharia Hardii* Atk. (M); *Tricholoma sejunctum* Fr. (O).

GASTEROMYCETES: *Astraeus hygrometricus* (Pers.) Morg. (F); *Calostoma cinnabarina* Desv. (F, O, S); *C. Ravenelii* (Berk.) Mass. (F); *Crucibulum vulgare* Tul. (O); *Lycoperdon fuscum* Bon. (W); *L. gemmatum* Batsch (O); *Mutinus Curtisii* (Berk.)

Fisch. (O); *Sclerodermа cepa* Vaill. ex Fr. (W); *S. Geaster* Fr. (F); *S. vulgare* (Hornem.) Fr. (O).

FUNGI IMPERFECTI: *Arthrobotryum atrum* Berk. & Br. (O); *Asteroma Lactucae* J. J. Davis (F, W); *Camarosporium Robiniae* (Westd.) Sacc. (W); *Cercospora atromaculans* Ell. & Ev. (F); *C. Boehmeriae* Pk. (F, W); *C. Diodiae-virginianae* Atk. (F, W); *C. effusa* Berk. & Curt. (F, W); *C. erythrogena* Atk. (F, W); *C. granuliformis* Ell. & Halst. (W); *C. Kalmiae* Ell. & Ev. (W); *C. Rhoina* Cke. & Ell. (F, O, W); *C. smilacina* Sacc. (F, O, W); *C. Smilacis* Thuem. (O); *Coccospora aurantiaca* Wallr. (W); *Coryneum triseptatum* Pk. (W); *Cylindrosporium acerinum* (Pk.) Dearn. & House (O, W); *C. hiemale* Higgins (W); *C. saccharinum* Ell. & Ev. (W); *Dactylium dendroides* Bull. ex Fr. (F); *Darluca Filum* (Biv.) Cast. (F, W); *Fusicladium Robiniae* Shear (W); *Gibellula arencarum* (Schw.) Syd. (F); *G. pulchra* (Sacc.) Cav. (F); *Graphium Hamamelidis* Van Hook (F, W); *Illosporium caespitosum* Ell. & Ev. (W); *Isaria farinosa* (Dicks.) Fr. (F); *Isariopsis clavispora* (Berk. & Curt.) Sacc. (W); *Leptothyrium foraminulatum* Sacc. & Ell. (W); *Macrophoma phacidiella* (Cke. & Ell.) Berl. & Vogl. (W); *Marssonia Populi* (Lib.) Sacc. (W); *Monochaetia camptosperma* (Pk.) Sacc. (W); *M. Desmazierii* Sacc. (W); *Papulaspora candida* Sacc. (W); *Pestalotia macrotricha* Klebh. (F); *Phyllosticta maxima* Ell. & Ev. (W); *P. Nyssae* Cke. (O); *P. smilacina* (Pk.) Dearn. (O); *Pleurocolla compressa* (Ell. & Ev.) Diehl (W); *Polythrincium Trifolii* Kze. (F, W); *Pseudographium hispidulum* (Ell.) Jacz. (F); *Ramularia Oxalidis* Farl. (W); *Sepedonium chrysospermum* (Bull.) Fr. (F, W); *Septoria acerina* Pk. (F); *S. betulicola* Pk. (W); *S. Cacaliae* Ell. & Kellerm. (W); *S. Rubi* Westerd. (F, W); *S. Rubi* var. *pallida* Ell. & Holw. (O); *Sphaeronema pruinosa* Pk. (W); *Sphaeropsis Ellisii* Sacc. (W); *Sporocybe Rhois* (Berk. & Curt.) Sacc. (W); *Sporotrichum Quercuum* (Thuem.) Sacc. (W); *Tubercularia vulgaris* Tode ex Fr. (W).—DAVID H. LINDER.

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